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The St. Croix River Arch Bridge; Minneapolis, St. Paul & Sault Ste. Marie Ry.

By PIERCE P. FURBER, C. E.*

A new arch bridge across the St. Croix River was completed last summer for the Minneapolis, St. Paul & Sault Ste. Marie Ry. The structure is the most important of a number of improvements carried out by the management during the past two years. In the spring of 1909 the "Soo" Line secured control of the Wisconsin Central Ry., giving the road an entry into Chicago. This is now known as the Chicago Division of the Minneapolis, St. Paul & Sault Ste. Marie Ry. Several cut-offs were planned, among them the New Richmond Cut-off, between New Richmond, Wis., and Withrow Junction, Minn., at which point the new line joins the main line of the Soo; the St. Croix River Bridge forms part of the work of this cut-off.

The map, Fig. 5 herewith, shows the location of the new cut-off and the old line, also the location of the old and new bridges. The grade on the new line does not exceed 0.5%, whereas the old maximum grade was 1.3%. Curvature has been reduced from a maximum of 6° to 1° 30', and a total of 1223° was eliminated between New Richmond and Carnelian Junction, a little east of Withrow, where the new line finally leaves the old.

The old line crossed the St. Croix about five miles above Stillwater, Minn., on a bridge consisting of ten Whipple truss spans of about 160 ft. each, with a steel trestle approach on the Wisconsin side, the total length of bridge being nearly half a mile. The structure was built in the latter part of the '80's. Investigation showed that the superstructure was entirely inadequate for the demands of the present day. This sealed the fate of the old bridge, although the surveys also showed that the most advantageous location of the new crossing could be made about a mile upstream from the old bridge. In addition to this, the new line was located at a much higher level. Base of rail for the new bridge is practically 185 ft. above ordinary water, or nearly twice the height of the old structure, whose deck was about 100 ft. above ordinary water.

At the site of the new bridge the St. Croix

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FIGS. 1 AND 2. THE NEW BRIDGE OF THE MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RY. OVER THE ST. CROIX RIVER, NEAR STILLWATER, MINN.

Fig. 3. Erecting West Arch on Falsework.

Fig. 4. Cantilever Erection of Second Arch.

FIGS. 3 AND 4. ERECTION OF ST. CROIX RIVER BRIDGE, CHICAGO DIVISION OF THE MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RY.

flows through a wide valley, with bluffs on each side averaging about 200 ft. high. The channel is about 300 ft. wide at ordinary stage, and the river floods the valley to its full width of 1,800 ft. only during times of extreme high water. The bluffs are of sandstone, which outcrops on the face of the bluff at each side of the river, but dips under the bed to a maximum depth of about 130 ft. The valley is filled with material varying from fine silt to sand, gravel and boulders.

Selection of Type.

A single-track bridge to accommodate engines corresponding to Cooper's E-55 loading was required. A concrete arch bridge was considered favorably on account of permanence, but the dead weight of the spans would have greatly increased the cost of foundations. In conjunction with the question of foundations, the requirement of but a single track and the necessity of winter erection at such great height above the river (185 ft.) precluded the building of this type of structure.

A steel bridge having been determined upon, a study was made of the relative economy of various types. Ordinarily a trestle composed of towers and girders is the most economical form of steel railroad bridge. The superstructure is cheap and is easy to erect, and foundations do not amount to much. But in the case of the St. Croix Bridge it was known that the foundation for a plate-girder trestle would have to be carried on piling and made much more massive than usual, on account of the character of the soil and liability to action of flood waters upon them. However, a bridge of this type was designed, with alternate girders and towers, the latter being approximately 150 ft. high.

At the same time it was thought that an arch bridge would offer many points of advantage. Solid rock foundations were available on either shore at the base of the bluffs, which made an arch design practicable, inasmuch as the foundations for the end spans could be given a firm footing in the rock. A design was therefore prepared on these lines. The bridge consisted of five 350-ft. three-hinged arch spans, with a rise of 124 ft. and crown depth 25 ft., making the end posts approximately the same height as the towers of the trestle design. These five spans covered the distance across the river valley between the bluffs; they were supplemented by approaches at either end consisting of girders and towers.

A comparison of these structures developed some difference of opinion, mainly regarding the cost of foundation work in each case. It was accordingly decided to call for bids on both designs and to invite alternate designs for the structure. Tenders were received from different bridge companies. Several companies submitted alternate designs, consisting of riveted truss spans supported on steel towers.

The plate-girder viaduct showed a considerable saving in superstructure compared to the arch bridge, with the truss bridge between the two. On the other hand there was more than enough to offset this in the reduced estimate of cost for the foundations for the arch bridge. With these figures in mind it was decided to adopt the arch as being the most desirable and economical.

A three-hinged arch of 350-ft. span for railroad traffic is sufficiently unusual to merit attention. It is very rarely the case that a location will lend itself readily to this type of structure, and the three-hinged arch as ordinarily built has been considered lacking in stiffness to such an extent as to be unsuitable for railway bridges. This view of the matter is due principally to the fact that designers of arch bridges have invariably made the crown depth so small as to admit of great deflection. The three-hinged type has been little used for railway bridges on this account, and the two-hinged arch has the disadvantage of being statically indeterminate, and is also subject to severe temperature stresses. The foundations must be immovable, or else stresses will be induced which will endanger the structure. These seeming disadvantages have prejudiced American engineers in favor of simply-supported structures for railway bridges. By using a three-hinged arch of relatively large crown depth, a statically determinate structure having a high degree of stiffness is obtained.

At the same time a partial continuity over the center hinge was obtained by a novel expedient. The middle panel of the top chord is a girder simply supported on bearing plates on the adjacent chord members, which project a short distance beyond the panel-points. There are five of these plates, alternate steel and phosphor bronze. Part of the web of chord U2 U3 (panel next middle) was cut out to provide a seat for the middle chord-section, girder U3 U3, the web of which was also cut away, permitting the ends to lap. The webs of both members were stiffened up with angles and reinforcing plates at

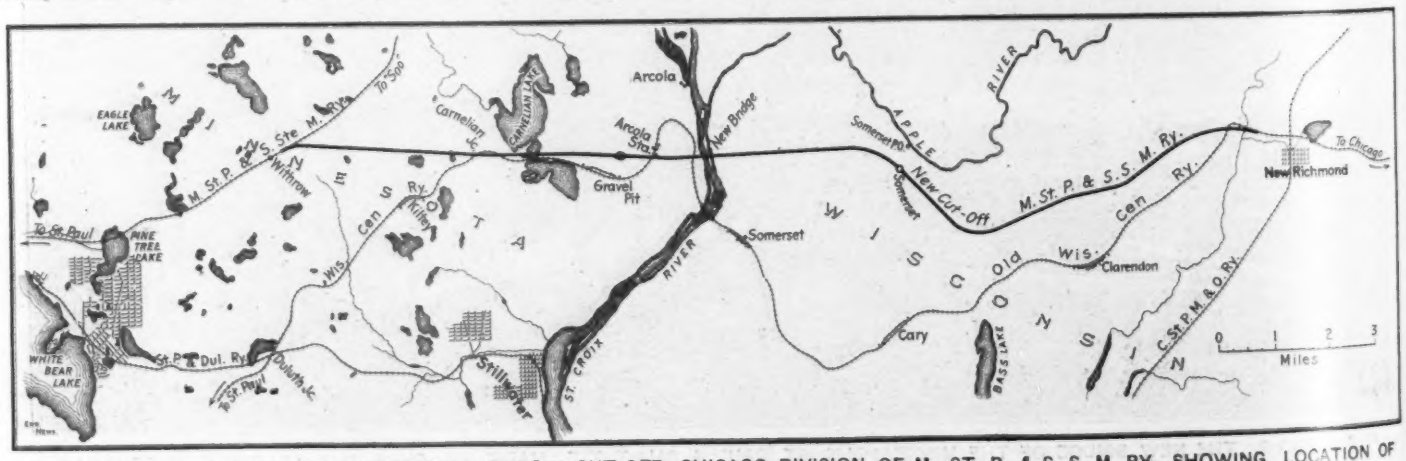


FIG. 5. SKETCH MAP OF NEW RICHMOND-WITHROW CUT-OFF, CHICAGO DIVISION OF M., ST. P. & S. S. M. RY., SHOWING LOCATION OF ST. CROIX RIVER BRIDGE.

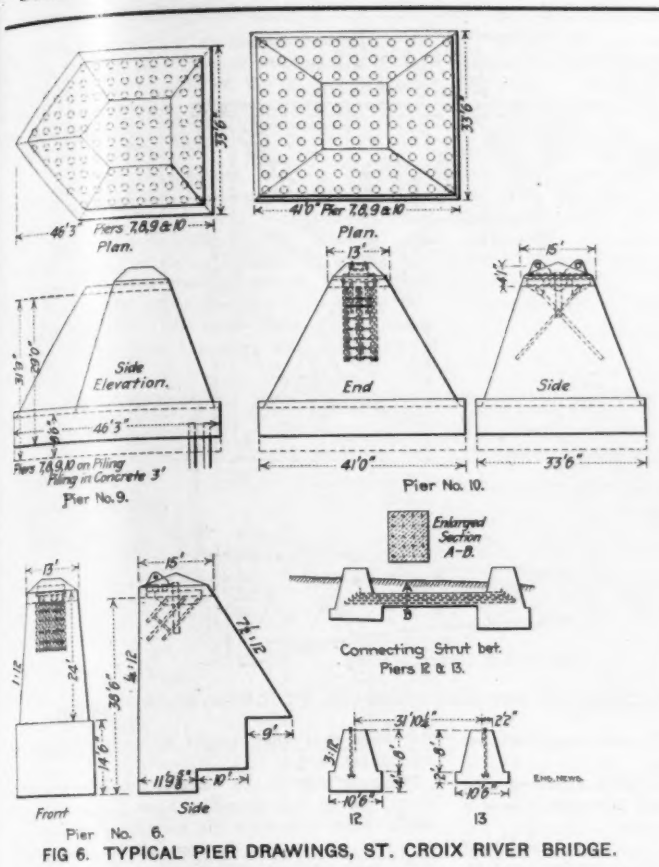


FIG 6. TYPICAL PIER DRAWINGS, ST. CROIX RIVER BRIDGE.

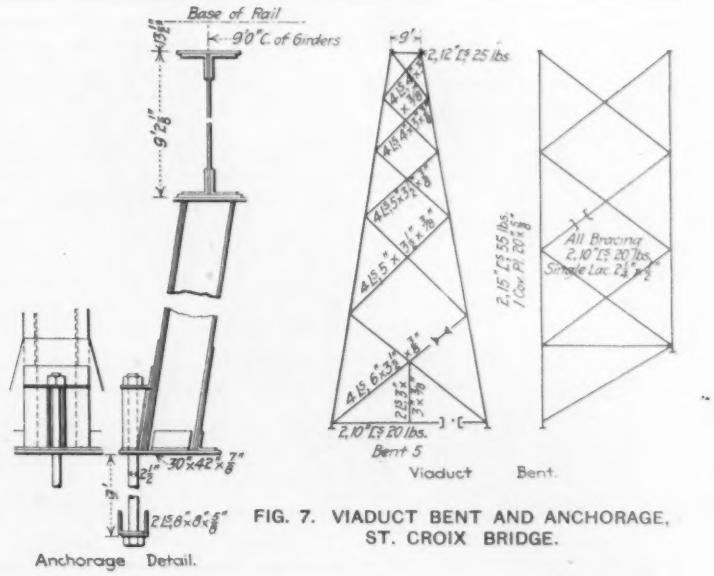


FIG. 7. VIADUCT BENT AND ANCHORAGE, ST. CROIX BRIDGE.

the shallow portions, and horizontal angles were riveted to the webs, those for U3 U3 on top and those for U2 U3 underneath the expansion joint. Enough space was left between these seat angles to admit the bearing plates. Slots were cut in the middle of these plates at one end where they project beyond the opening, thus allowing the plates to straddle the webs of adjoining chords. The plates were bolted to the horizontal angles on the chords, and were free to slide under temperature changes.

This device enables the arch to move freely under temperature changes, and to act as a three-hinged arch under dead-load. Under live-load, however, the weight of the train locks these plates together by their mutual friction, making the structure a two-hinged arch in effect. The alternating steel and bronze plates provide against trouble from rusting. The details of this joint are shown in Fig. 11.

General Features of the Bridge.

The stresses in the arch truss were computed considering the truss as a three-hinged arch, and also as two-hinged. As there was very little difference in the stresses under these conditions, the sections had to be modified but slightly to take care of the load in either case. Erection stresses were computed for the half arch as a cantilever. These calculations developed the fact that erection as a cantilever would not strain any member beyond its maximum in the finished structure. Stresses due to temperature were eliminated from the main trusses due to the type of structure employed, and wind stresses were low due to the batter of the trusses. The Warren type of bracing was adopted for the web of the arch truss. Reversals of stress occur in all the web-members.

The grade is 0.5% sloping eastward throughout the length of the bridge. The end posts of the arch spans and all columns on the approach trestles were inclined normal to the grade line. The tops of arch piers were built on a line parallel to the grade line, giving them a slight inclination from the horizontal. The lower-chord panel-points of the arch are on an arc with a radius of about 185 ft. and symmetrical about a center line normal to the grade line.

The great height of the structure for a single-track crossing made it advisable to batter the trusses. An inclination of 2:12 with the vertical was employed. This batter greatly increases the resistance to wind pressure, although it introduced an interesting problem in detailing the bent-plate connections. No great trouble was experienced on this account, however, the lateral plates being reduced to simple bends by cutting a slot in the plate on the line of intersection of top flanges of adjacent bottom chords.

As the bottom-chord members meet each other at an angle, a bend in the lateral plates was made necessary. The webs of the bottom chords are in an inclined plane parallel to the plane of the truss. Hence the cover-plates, and consequently the lateral plates riveted thereto, had to be given an inclination in order that they should be normal to the webs. The lateral plates thus required another bend on each side of the panel point to make them perpendicular to the longitudinal axis of the bridge. This was necessary in order to have the lateral plates in the plane of the bracing, which plane must be perpendicular to the center line of bridge. A slot on the line of the first bend, extending from the inside edge of the plate to the bend line of lateral connections, rendered the lateral bends a simple matter. The gussets connecting top chords to web members were bent, keeping the top chord vertical. The lower-chord gussets were given a single bend to bring them into the plane of the truss on each side of the panel-point.

Fig. 8. One-Bolt Anchorage of Viaduct Posts, St. Croix River Bridge.

The track ties rest directly upon the top chord, which is composed of heavy box-girders spaced 9 ft. c. to c. This does away with floorbeams and track stringers, and effects a saving in metal and labor, besides providing a simpler deck with a very solid bearing for the track on the broad flanges of the top-chord girders. These girders are 50 ft. or one panel long, and are composed of two webs 5 ft. deep, a 34-in. cover plate and eight flange angles, four each top and bottom.

The bottom chord L_0 L_1 was composed of two webs 30 ins. deep, with a top-cover plate and four angles on each flange. Lacing in the plane of the bottom flange consisted of angles. The sections of bottom chords were reduced toward the crown, where the cover-plate was omitted for the two middle panels and the chords laced both top and bottom. The end bottom chord, a member about 75 ft. long, weighed 26 tons, which shows the massive character of the construction.

The end posts of the end arches were made up of two web-plates, with four angles on each, and a cover-plate on one side; cover-plates were not used on the end posts of the intermediate arches. The end posts of the end arches had to take the load from one end of the adjoining 100-ft. girder in addition to the stress carried as a part of the arch. The end posts were braced transversely after the fashion of trestle bents. Web-members of the arch truss were made up of the same type of section as the end posts, except that there were no cover-plates, and the sections were lighter.

Due to the method of erection, connection plates for truss members were shop-riveted to the outer end of all members, that the erection might be carried ahead from one end of the arch. This reversed the plates on the opposite ends of the arch. For the middle span, however, the plates were the same, as the erection proceeded from both ends. Field holes were reamed to an iron template in the shop.

The details consist of rigid connections throughout. All splices were proportioned to develop the full strength of members and no dependence was placed on abutting joints between compression members.

The top-chord girders were connected with a single diagonal system of angle bracing, and were also swaybraced at the panel-points of the lateral truss with cross-frames, the construction being similar to ordinary plate-girder bracing. Crossed diagonal bracing was used in the bottom lateral system, the braces being composed of four angles laced together. The struts were of the same depth as the bottom chords, and

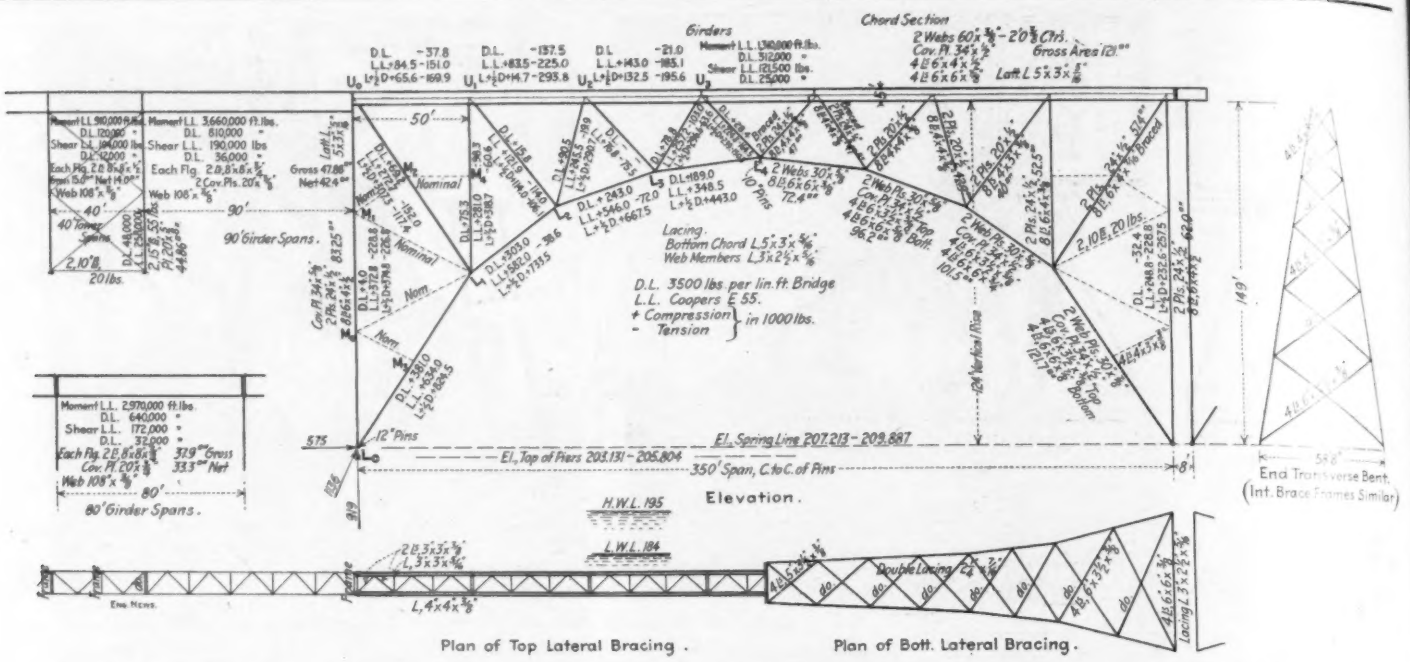


FIG. 9. STRESSES AND SECTIONS OF 350-FT. THREE-HINGED ARCH SPAN AND APPROACH GIRDERS, ST. CROIX RIVER BRIDGE.

connected to them through large lateral plates. All web-members were braced transversely by means of struts similar to the bottom-chord bracing.

The skewback was another novelty in bridge construction. The end pins were inclined, being driven normal to the plane of the trusses. A cast-steel shoe with inclined jaws received the bottom-chord plates and the pin. This shoe was cast with a horizontal bottom, and rested on a cast-steel bolster. The bolster was bolted to a steel frame built into the concrete pier. Five lines of horizontal channels set directly on top of the pier with upright channels projecting above to take the thrust of the shoe. A series of angles inclined at 45° served to anchor these channels to the mass concrete. The angles were riveted to connection plates which were in turn riveted to the web of the channels. This frame was assembled within the forms and braced in position while pouring the concrete up to the under side of the horizontal channels. Then the spaces between these channels were grouted through holes in the cast bolster. The shoe was then set in position.

After the span was swung and adjusted, the shoe and bearing were encased in concrete nearly up to the lower line of the pin.

For the intermediate piers the dead-load thrusts are balanced, of course, while live-load on one arch produces an excess thrust in one direction. The anchorage was calculated to provide for this condition, the angles embedded in the pier serving to take the tension in either direction. The same condition would obtain during erection as a cantilever.

At the end arch abutments, however, the placing of shoes on a level bearing is quite out of the ordinary. The anchorage angles enclosed in these piers were disposed a little differently than for intermediate anchorages, and additional rods were concreted vertically in the pier and projected therefrom. Concrete was afterward deposited around the projecting portion of these rods and over the shoe of the arch, as for the other piers, to develop the shearing strength of the rods that they might assist in taking the horizontal thrust.

The resultant of the vertical pressure and horizontal thrust was found to have a comparatively small inclination with the vertical, due to the inclination of the end bottom chord. The resisting forces against sliding were: Friction of the base of shoe against the bolster, resistance of the vertical channel thrust-block to shearing and bending, tensile strength of angles embedded in the concrete, and shearing strength of the concrete and vertical rods. Calculations showed that the strength of the construction was sufficient to insure an absolutely rigid skewback. The advantage of building the skewback in this way was to make the proper adjustment of the arch spans more simple.

For adjustment of the spans a clearance of 9 ins. was left between the back of the shoe and the projecting channel thrust-block. There was inserted in this space behind the shoe a screw wedge which could be operated to move the shoe horizontally, thus raising or lowering the span

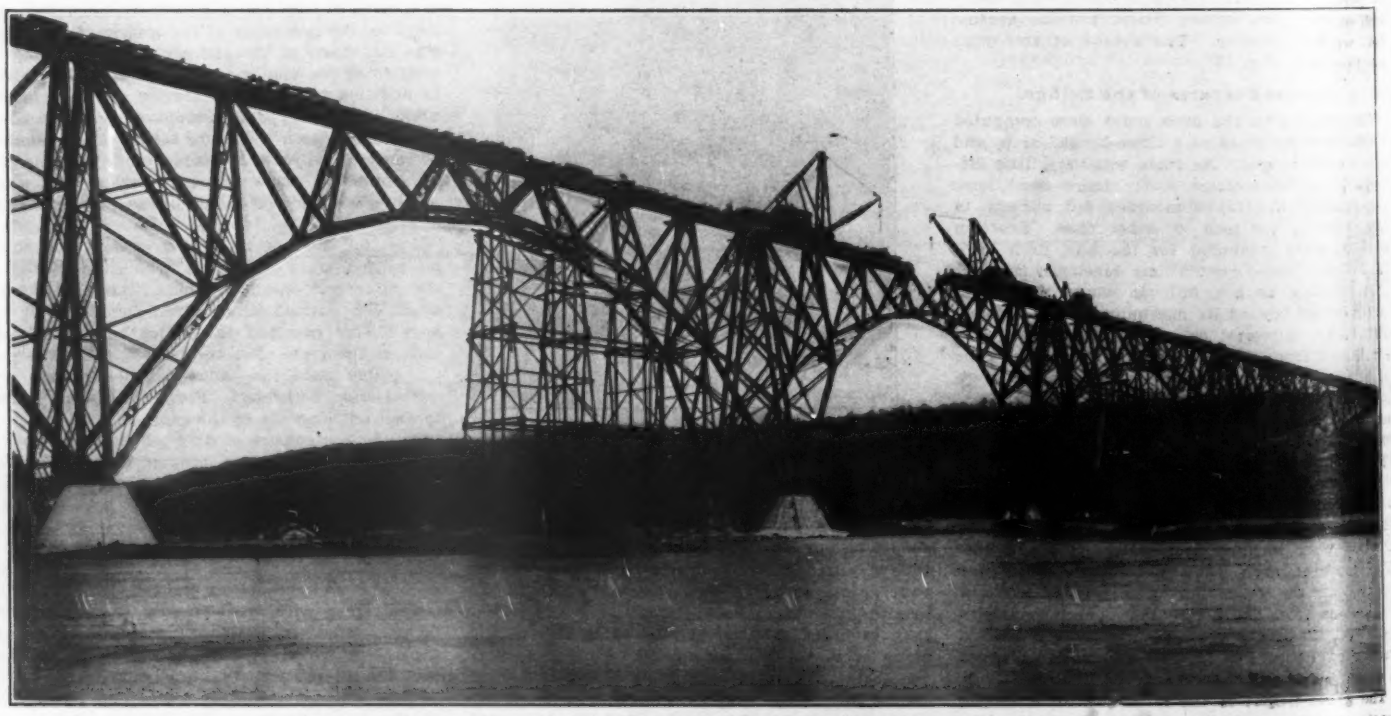


FIG. 10. JUNCTION OF ST. CROIX RIVER BRIDGE AT CENTER OF MIDDLE ARCH.

as required to bring it to proper position after erection. The arrangement is shown in Fig. 13; Fig. 14 is a photograph of the shoe. The advisability of providing efficient means of adjusting the spans was brought out clearly in the erection of the first arch.

Erection.

The end arches were erected wholly on falsework, beginning at the shore ends and working out. The timber settled slightly, bringing the structure below grade sufficiently to throw the end bottom chords several inches beyond the point they should have reached to properly engage the shoes on the river piers. They were also out of line, and the shoe was shoved over to make a connection. This left inadequate clearance for the wedges.

The span had to be raised to admit the wedges at one end for final adjustment. Temperature changes aided in gaining the additional clearance. In the early morning the shoe was forced out slightly by wedging. An increase of temperature during the day lifted the span from the falsework, enabling shims to be forced in to maintain the span in this position until the temperature fell, when the shoe was drawn away from the thrust-block and the clearance increased. Then steel shims were driven behind the shoe. In the course of several days, repeating the process gained enough space for entering the wedges and adjusting the arch to its proper position.

Erection of the bridge was carried on from both ends, two complete outfits being used for the work. A derrick car at each end was employed for loading and handling material to another car which erected the steel. These cars were of the ordinary type; they had timber booms 70 ft. long and were capable of handling 50 tons. The heaviest pieces (with the exception of the 100-ft. approach girders) were the end bottom chords (about 26 tons) and the end posts (28 tons).

The first arch at each end was erected entirely on falsework as noted above. The falsework was lowered from the car one panel in advance of the steel. The second span was cantilevered from the shore span as far as the crown, and the far half was erected on falsework in the same manner as the end arches. The falsework was required to take only the load of the half arch resting upon it. The cantilever portion was self-supporting during erection of the second half of the arch. The middle span of the set of five was cantilevered out from both ends.

A little difficulty was encountered by the erectors in building the first arch due to the connection of end post to end bottom chord. The pin plates were shop riveted to the chord, making the field splices on the end post. This arrangement required erection of the chord in advance of the end post. Different methods of taking care of the difficulty were employed by the erectors at each end. On the Wisconsin or east end, the approach girder adjacent to the arch was carried on falsework, thus allowing the derrick car to get out and erect the first panel of the bottom chord, then drop the end vertical and make the connection at the shoe. On the Minnesota side, the end post was swung out while the car stood back on the tower composed of bents 12 and 13. The post was supported on a timber crib at its base, and the 100-ft. girder span was erected upon it, after which the derrick car could reach out and set the bottom chord upon the shoe. The end post was then jacked into place and bolted up.

In erecting the three middle arches as cantilevers it was necessary to tie to the last span erected. The tie consisted of angles bolted to both top chords, which extended over the end posts, with a clearance of 6 ins. between ends of chords. But as the tie could not be made at this point until the first panel of top chord on the cantilever span was in place, the end posts were also tied together by means of long rods. The end posts on adjoining spans over the same pier were spaced 8 ft. apart on center lines. The tie-rods were 13 ft. long and were given a bearing on timber blocks which transmitted the bearing to the end posts. These tie-rods served to hold the first panel until it was possible to bolt up the hitch angles between the top chords.

Field riveting of the arch spans was commenced after three panels had been erected and properly lined up. This delay was intended to provide against difficulty in keeping the truss in alinement, as it would have been a rather hard job to move the span around on the falsework after it had been riveted up.

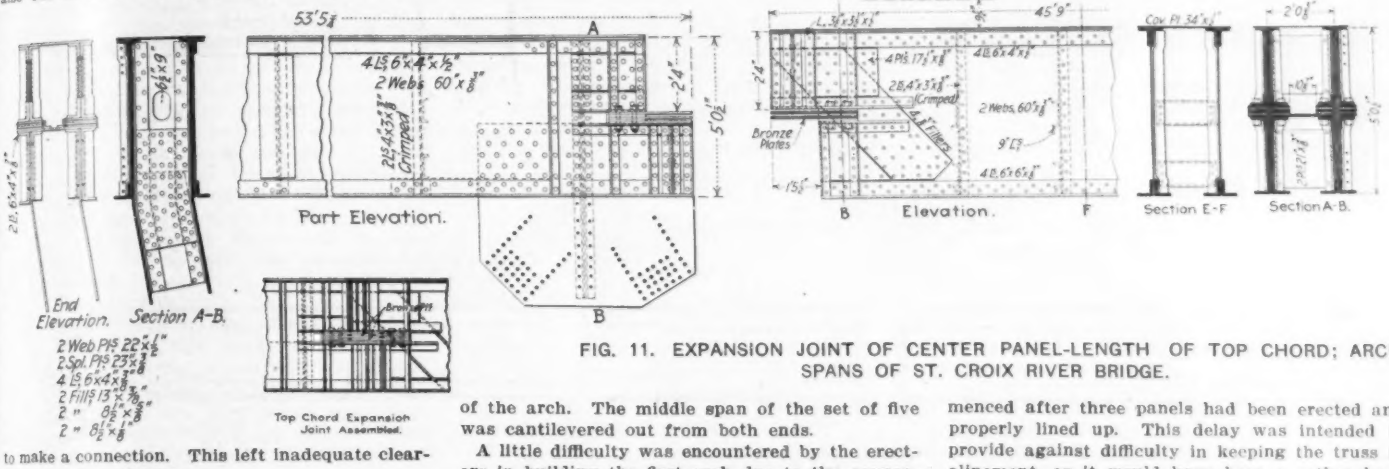


FIG. 11. EXPANSION JOINT OF CENTER PANEL-LENGTH OF TOP CHORD; ARCH SPANS OF ST. CROIX RIVER BRIDGE.

Approach Viaducts.

The approach trestles are of ordinary construction, with the exception of the anchorage of the columns. All towers are braced longitudinally and transversely with stiff bracing; they have bottom struts in both directions and transverse top struts. The anchorage consists of a single 2½-in. bolt on the outside of each column, embedded to a depth of 9 ft. in the concrete pedestal. Two large angles serve to anchor the bolt to the pier. An iron tube of conical shape, 8 ins. in diameter at the top, was placed in the pit around the anchor bolt before concreting to permit of adjusting the bolt to the column base.

The connection of approach girders to end posts of the arches consisted of a seat or shelf riveted to the post for receiving the girder. As the top chords of the arches were 5 ft. deep and the approach girders 9 ft. deep, a special end bearing was designed for the girder. The bearing was made about midway the height of the girder and consisted of seat angles riveted to the web, which was cut off below to clear the

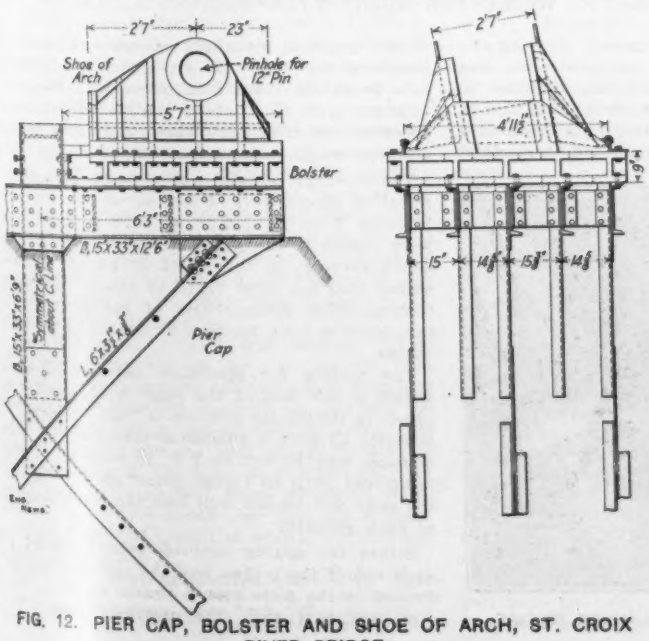


FIG. 12. PIER CAP, BOLSTER AND SHOE OF ARCH, ST. CROIX RIVER BRIDGE.

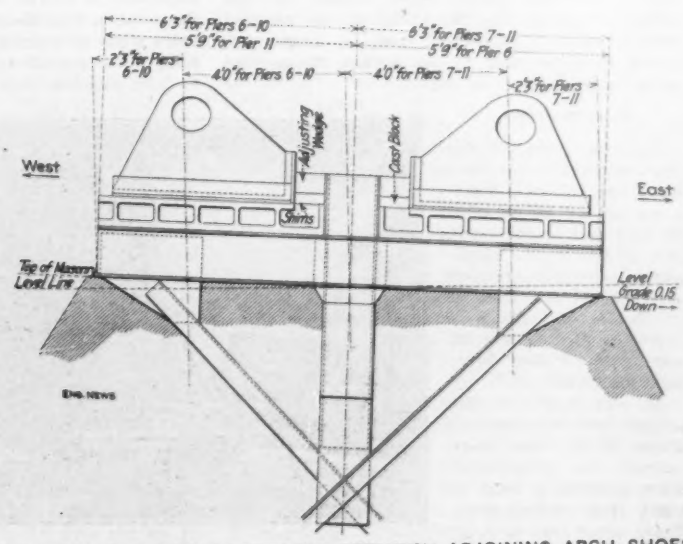


FIG. 13. ADJUSTING WEDGES BETWEEN ADJOINING ARCH SHOES, ST. CROIX RIVER BRIDGE.

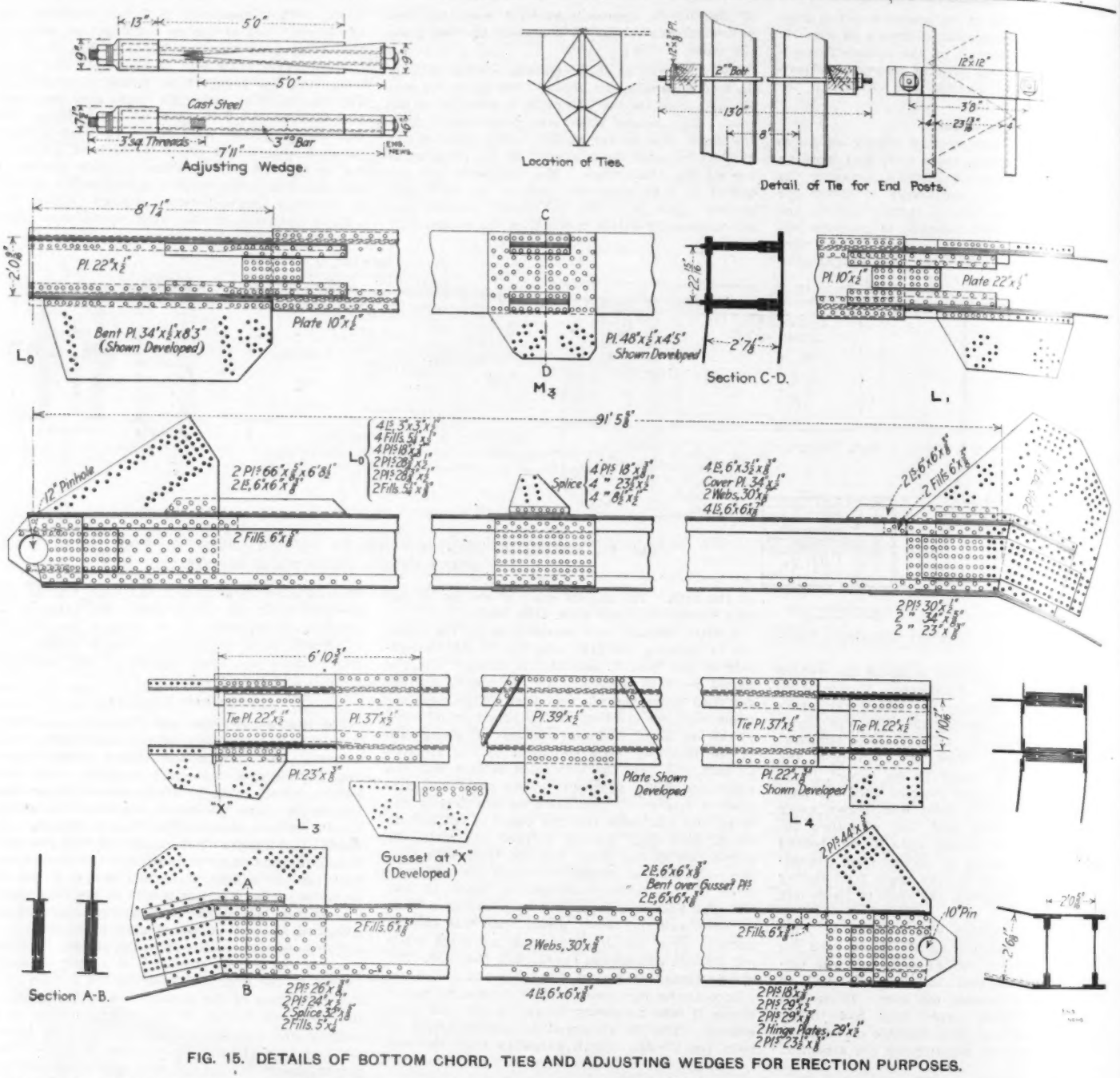


FIG. 15. DETAILS OF BOTTOM CHORD, TIES AND ADJUSTING WEDGES FOR ERECTION PURPOSES.

shelf on the end post. Vertical stiffener angles and reinforcing plates were riveted to the girder to provide for the shear on the reduced section of web plates. A pair of angles inclined from the seat to the bottom flange also served to stiffen up the web.

Foundations.

Concrete pedestals for the approach spans were built into the solid sandstone on top of the bluff at each side of the river. The end arch abutments were also founded on rock, at the base of the bluffs, but the four piers in the middle of the river valley were built on piles.

As the feet of the arches have a spread of about 60 ft. they were carried on independent piers, making a total of eight pile foundations. These piers rest each on 110 piles, 70 to 85 ft. long, driven with a steam hammer. Driving was continued to refusal or until the penetration was not over ¼-in.; 25 to 40 mins. was required to drive a pile to a depth of 50 to 80 ft. The tops of piles were embedded in concrete to a depth of 4 to 5 ft., and the piers were riprapped thoroughly, providing ample protection against scour and exposure of the piles. The river piers were carried to a height of about 8 ft. above high water, or approximately 15 ft. above the ground; with one exception the river piers were on dry land during ordinary water.

FIG. 14. END SHOE OF WEST ARCH, ST. CROIX RIVER BRIDGE.

The footings for the trestle posts were pyramidal in shape, 4 ft. 4 ins. square on top and battered 3 to 12. They were 10 ft. high, and were buried in the ground from 6 to 8 ft., this depth varying, as the length of anchor bolt required that the total depth be attained for each footing while irregularities of the ground surface allowed some footings to project higher than others.

The footing for upstream pedestal 12 came within a few feet of the edge of the bluff. In order to insure its position it was anchored to pedestal 13 with a reinforced-concrete tie. This member was 18 ins. by 2 ft. in section. It was reinforced with 20 1⅛-in. round rods, hooked at the ends and lapped well into the mass concrete of each pedestal.

Plants for mixing concrete were installed at each end of the bridge, and the material was delivered to the piers over a timber trestle a little way upstream from the upstream piers. The

dock of this trestle was built several feet higher than the tops of the piers. From the mixing plant at the west end, the concrete was ferried across the main channel by means of a cableway, and deposited into a ½-yd. car on the trestle. The cableway was about 400 ft. long, and the drop from the mixing plant on top of the bluff to the deck of the trestle was nearly 100 ft. At the other end, the concrete was conveyed through a chute into a hopper which dumped into the car. Cars on this trestle hauled concrete to the piers as required.

Grading was begun in the summer of 1910. Foundation work for the new bridge was started in June, 1910, and erection of superstructure was commenced about the first of October. The bridge was completed in June, 1911, the first train crossing the structure on June 3.

The work was carried on under the general direction of Mr. Thomas Greene, chief engineer of the M., St. P. and S. S. M. Railway. Mr. C. N. Kalk, assistant engineer, had direct supervision, while Mr. C. A. P. Turner, M. Am. Soc. C. E., as consulting bridge engineer to the railroad company, designed the structure.

The total weight of steel was slightly over 5,000 tons, including guard angles and the pier reinforcement. The steelwork was manufactured by the American Bridge Co. and erected by the Kelly Atkinson Construction Co. of Chicago. About 10,000 cu. yds. of concrete was placed in the foundations, this work being done by the railroad company's forces, in charge of Mr. R. G. Hase. George W. Oakes & Co. of St. Paul had the contract for driving piles, which aggregated 60,670 lin. ft. Robert W. Hunt & Co. had charge of the inspection of the metal for the railway company.

An Inverted-Arch Foundation of Reinforced Concrete.

By JAMES E. PAYNE.*

An arched building foundation of reinforced concrete was recently built at 418-426 West 25th St., Manhattan, New York City, to the writer's designs. The type is unusual, but it has distinct advantages in simplicity and low cost. Its adoption in the present case was due to the desire to get a shallow foundation; the soil is running sand and the excavation had to be sheeted for the full height on three sides, so that obviously every foot of depth adds to the cost and difficulty of the work.

The building is about 89 × 125 ft. and will be eight stories high above ground. It is to be used as a warehouse. The floor loads are 250 lbs. per sq. ft. and the roof load 30 lbs. The dead-load is 5,350 tons and the live-load, taken at its full amount on all floors, is 11,100 tons, making the total maximum foundation load 16,450 tons. The ground area inside the building line is 11,100 ft. The load is therefore about 1½ tons per sq. ft. A loading of 3 tons per sq. ft. was taken to be safe and the foundation was designed on the basis of this loading.

The foundation consists of a series of inverted concrete arches running in both directions between columns, as fully shown by the drawing herewith. The arches are 12 ins. deep at the crown and 42 ins. under the cast iron column bases; they vary from 4 to 5 ft. in width. The reinforcement comprises ⅞-in. round corrugated bars, straight, spaced 6 ins. on centers in the extrados; and 1⅛-in. bent bars, spaced 6 ins. on centers, in the intrados.

The extrados of the arch was designed flat to give an even bearing on the soil, and the bars in the bottom (straight) are two spans long and are lapped at alternate columns, so that half the bars are continuous under each column. The splices of the others are long enough to develop the full tension in the bars. It was thought that by following this method, more monolithic foundations would be secured and that the foundation would get the benefit of whatever cantilever action there might be.

Before the detail foundation plans were made the bank had been braced and the adjoining building shored, and it was found that some of the 12 × 14-in. braces prevented the placing of the arches as designed. This difficulty was very easily overcome by lowering and curving the extrados the necessary amount, and making the intrados curve deep enough to go under the brace.

The reason for adopting this type of foundation was that the depth limit fixed by the architect was not sufficient for isolated footings, and that steel I-beam grillages would have cost about 25% more in place than the concrete arch foundation. Isolated footings could have been used only for the 8 interior columns (out of 48) as the wall column and the columns next the wall had to have continuous footings on account of the ruling by the Bureau of Buildings that footings shall not extend beyond the building line.

All of the end spans are made of either rectangular or T-shaped concrete beams, in order to provide for the thrust from the adjoining arch, which is taken up by the friction between the soil and the foundation, developed by the loads from the columns, and also taken up by the thrust against the outside bank. It was found more economical to follow this method than to make the end span an arch with the necessary tie rods, which would have required covering with concrete.

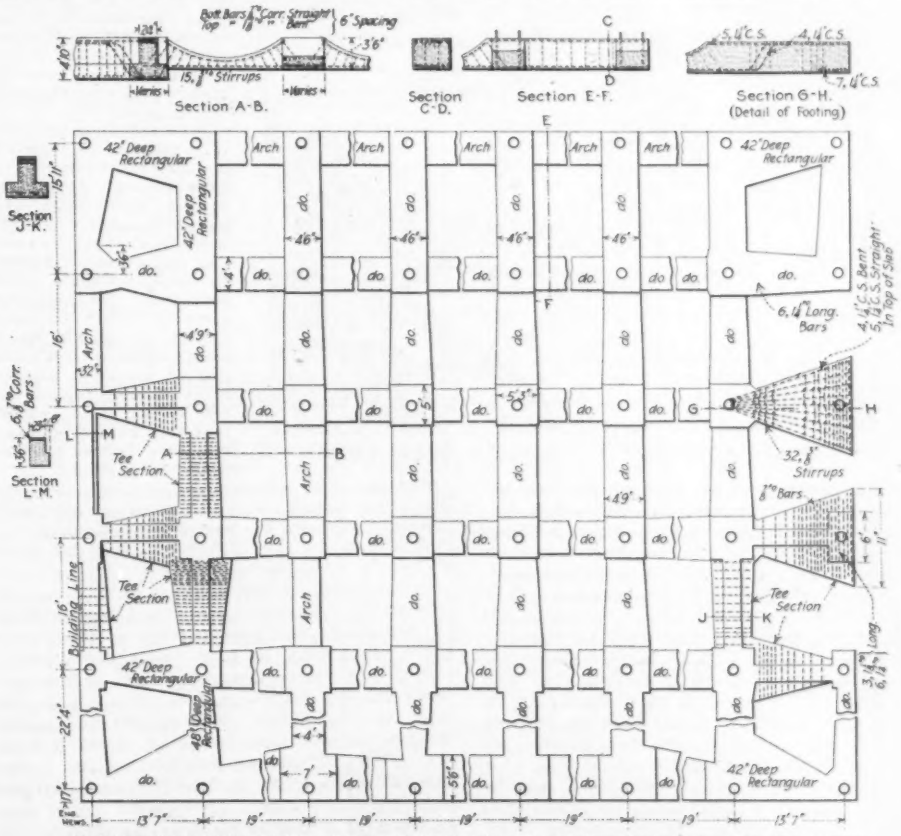
The widths of the arches and beams were varied to accommodate the varying column loads, so as to give a uniform soil-pressure throughout the entire foundation.

Resal's method for determining the direction and intensity of stresses was used in designing the arches and the results were checked by Lossier's method.

The design as shown gives a foundation area of 4,860 sq. ft. On the basis of full live-load as above given, the soil pressure is 3.4 tons per sq. ft. But as full live-load on all floors is a very improbable condition, the live-load was reduced in arriving at the foundation load, by 5% on the 7th floor and an additional 5% on all succeeding floors, making an aggregate reduction of 1,940 tons or about 11.7% of the total. On this basis the soil pressure is 3.0 tons per sq. ft. The same arrangement of live-load would make the total load if distributed over the entire ground area of the site average 1⅓ tons per sq. ft.

Maximum local foundation pressure migh occur if one vertical line of columns for the whole eight floors were completely loaded and two adjoining lines of columns on alternate sides free of live-load. This condition would give a soil pressure somewhat higher than 3.4 tons per sq. ft. directly under the loaded column, but it is an improbable condition.

The possibility of cantilever action in a foundation of this kind is worth considering. If the arches should crack in the center and all arch action should be destroyed, each arm of the foundation beam extending from a column would have to act as a cantilever. The stress in the steel in the longest span would just about reach the elastic limit of the steel, 35,000 lbs. per sq. in.; the concrete stress would remain within safe limits, as the percentage of reinforcement at this point is only about 0.25%. The stresses in the other spans would be correspondingly less.



REINFORCED-CONCRETE ARCH FOUNDATION OF WAREHOUSE AT 418-426 WEST 25TH ST., MANHATTAN, NEW YORK CITY.

The steel used in constructing the foundation was structural grade, according to the specifications of the Association of American Steel Manufacturers. The concrete was of 1:2:4 mixture, using trap rock.

In building the forms 1-in. lumber was used to make the sides of the beams and arches; sand was filled in behind the forms. No attempt was made to salvage any of the lumber except the top board, which was easily removed.

In pouring the arches several vertical stops were placed extending down to the top of the arch, which made the intrados a series of steps instead of a curved surface.

The work was designed by Mr. F. R. Pradillo, Assistant Engineer in the New York office of the Corrugated Bar Co., and built by Mr. Thos. Larkin, President of the McKeon Realty Co., which owns the building, from plans prepared by Mr. Paul C. Hunter, Architect. The design was checked carefully and approved by the Manhattan Building Department.

The writer thinks that this type of foundation will come into use more frequently in Manhattan when its simplicity and low cost become more generally known.

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Power From Italian Mountain Streams at Heads From 656 to 2985 Ft.:—The Adamello Development.

By C. A. TUPPER.*

This paper describes what is known as the "Adamello" hydro-electric power development of the "Società Generale Elettrica dell' Adamello," of Milan, Italy, which includes two generating plants, one at Isola, Italy, operating under 910 m. (2,985 ft.) head, and the other at Cedegolo, having 470 m. (1,542 ft.) head. The problems dealt with are those incidental to the design, installation and continuously successful operation of equipment at such high heads, the insuring of durability, keeping down costs and providing for regulation of the output on a commercial basis. All of these appear to have been very well accomplished. During a recent European tour, the writer came across no more interesting or instructive example of modern engineering.

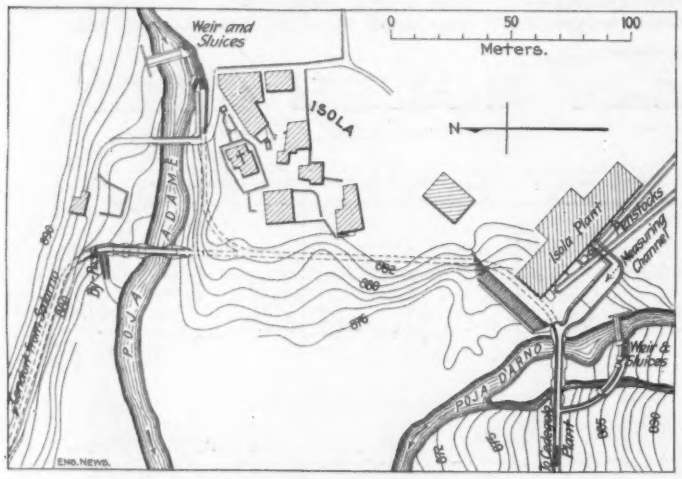

FIG. 1. ADAMELLO HYDRAULIC WORKS AT ISOLA, ITALY.

Looking at a map of Southern Europe, one will see along the frontier of Italy and Austria, between the Ortler Alps of the Tyrol and the large Lake Garda, a group of mountains known as the "Adamello," with high snow-capped summits, from which great glaciers descend to the valleys lying south and west. Towards the northern end, the principal flow from the glaciers and mountain springs is into the River Oglio, a tributary of the celebrated Po. The Oglio is fed largely from the River Poglia, which, in turn, derives its flow mainly from the streams known as the Salarno and the Poja d'Arno, the latter joining the main branch of the Poglia at the village of Isola. The Poja d'Arno rises in the Lago d'Arno, a lake completely surrounded by steep mountain slopes at an altitude above sea level of 1,790 m. (5,872 ft.).

The company above mentioned, which was chartered for the purpose of developing the water powers on the western slopes of the Adamello range, decided to begin by utilizing the flow obtainable from the Lago d'Arno at Isola and again at Cedegolo to utilize it in the River Oglio, reinforced by the flow of the Poglia and also by the waters of the Salarno, carried in a conduit to Isola. From Isola the combined flow from the Poglia; from Lago d'Arno and from the Salarno is conveyed to Cedegolo through a conduit, tunnel and pipe line. The power developed at Isola and Cedegolo is transmitted to Milan and its industrial suburbs, where there has been a steadily rising demand for electric current. In the following will be outlined first the development at Isola and secondly the one at Cedegolo. The drainage area available for the latter is about 95 sq. kilos. (37 sq. mi.) and the annual rainfall is so heavy that a natural discharge of about 2 cu. m. (78.6 cu. ft.) per second can be safely relied upon for the Cedegolo plant situated at 400 m. above sea level. The drainage area of the Lago d'Arno is limited to about 14 sq. kilos. (5.4 sq. mi.); but the lake has great depth and therefore impounds a very large volume of water. To develop the available power, the lake has been tapped at 25 m. (82 ft.) below its normal level, corresponding to elevation 1,790 m. (5,872 ft.).

The conditions are thus described by Director L. Zodel, of Zürich, Switzerland, who, as engineer for the turbine builders, Messrs. Escher, Wyss & Co., was largely responsible for the successful working out of the plans.

At elevation 1,790 m. (5,872 ft.), the surface area of the lake is about 578,000 sq. m. (6,185,000 sq. ft.), and at elevation 1,765 m. (5,789 ft.) is still about 367,000 sq. m. (3,927,000 sq. ft.), hence a useful volume of approximately 12,000,000 cu. m. (472,000,000 cu. ft.) is available. Annual rainfall of some 1,000 mm. (39.4 ins.) would be sufficient to make up this volume, but the records which have been taken prove the average fall to be considerably greater. Measurements of the discharge have further shown that about 300 litres (11 cu. ft.) per second flow out of the lake even in winter during the periods of least water; this leads to the belief that considerable quantities of spring water, partly from other drainage areas, must find their way into the lake throughout the winter months.

With these conditions, it is possible to draw off a constant volume of 2,000 litres (71 cu. ft.) per second for 7 to 8 hrs. daily throughout the 300 working days of the year, and to develop thereby an output of some 19,000 HP. Since the Adamello stations are intended mainly to supply Milan with power for peak loads and to act as a reserve plant during periods of low water, it is evident that this natural storage reservoir serves a most useful purpose.

The lake level can readily, and with very small outlay, be dammed up another 20 m. (65.6 ft.), thereby increasing the useful storage volume to 30,000,000 cu. m. (1,060,000,000 cu. ft.); this more than doubles the former capacity.

The additional water required to make use of this greater storage capacity is being obtained by deflecting the upper portion of the Poglia River (or Adamè, as it is called above Isola), which, with the necessary elevation, at the proposed intake, drains an area of about 21 sq. kilos. (8.1 sq. miles). The conduit and tunnel required have a total length of nearly 6 kilos. (3.7 miles). It has also been decided that a further fall of about 200 m. (656 ft.) can be utilized from the upper Poglia development by the construction of a turbine plant on the shore of the Lago d'Arno, since this is the differefice in elevation between the point where the new tunnel emerges from the mountain, above the lake, and the level of the lake itself. This third station will probably be erected later. When it is completed, the total fall utilized on the Poglia will be in round figures, the sum of 470, 930 and 200 m. (1,540, 3,050 and 660 ft.) or 1,600 m. (5,250 ft.).

In order to provide for the possibility that the level of the lake might be lowered to the level of the intake tunnel at elevation 1,765 m. (5,789 ft.) by a large consumption of water during a severe winter with a heavy and prolonged demand for power before the commencement of the spring thaws, the company has arranged to reduce the water level by a further 8 m. (26 ft.) and thus increase the useful storage by nearly 3,000,000 cu. m. (106,000,000 cu. ft.), by means of a floating pumping plant. Apart from the fact that the power available in the winter, during the most profitable time, is thereby still further increased, which, of course, is of very great importance for Milan and affects the income earning capacity of the station in no small degree, it is also possible by means of this pumping plant to lay all the intake works and the tunnel dry for inspection or possible repairs.

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The Isola Plant.

From the level at which the water of the Lago d'Arno is drawn off to the turbine inlets at Isola, there is a fall of 910 m. (2,985 ft.). In tapping the lake, a short adit was driven into the side of the cliff towards Isola, and a shaft sunk, to the level determined upon for the intake. Thence a circular tunnel was extended horizontally in both directions, first to the point where the penstock begins and then to the lake, the latter section being completed after a sluice gate had been constructed. This gate, which is set in a frame 1,600 mm. (63 ins.) square, having the same area as the tunnel. The intake level is at 1,764.5 m. and the proposed height of lake level will be at 1,809.5 m., so that the gate had to be built to withstand a head of 45 m. (148 ft.). Its design merits further attention.

At the discharge end of the tunnel about 90 m. (295 ft.) before its junction with the penstock, a vertical shaft has been cut through to the surface of the mountain slope above, 70 m. (230 ft.) to serve as a stand-pipe for taking up the pressure surges. It has a diameter of 7 m. (23 ft.). Both this and the sluice gate were planned with a view to the utilization of the higher lake level, which will be made possible by the proposed dam.

PIPE LINES.—In planning the construction of the penstock lines to the Isola power-house, the greatest care had to be exercised, as Mr. Zodel points out, in order to avoid any considerable loss of head and, at the same time, to keep the water velocities in the pipes within the lowest possible limits. Against this were considerations of both an engineering and financial nature, which limited to comparatively small dimensions the sizes of pipes dealing with the high pressure of over 1,320 lbs. per sq. in.

The question of utilizing this great head in two stages was therefore proposed, and seemed all the more tempting in that the mountain slope provided a level spot exactly in the middle of the fall, where ample space could be found for a power station. The pipe line itself would then have been much cheaper, besides being within conditions of pressure, etc., which had already proved eminently satisfactory in the operation of other stations. The construction and running charges of the whole plant with two central stations would have been, on the other hand, considerably heavier; and a balancing reservoir would be necessary with such an arrangement to receive the water from the turbines of the upper station. A well known plant similar to this had already been constructed in Italy on Mont Cenis, with a total fall of 890 m. (2,920 ft.) used in two stages.

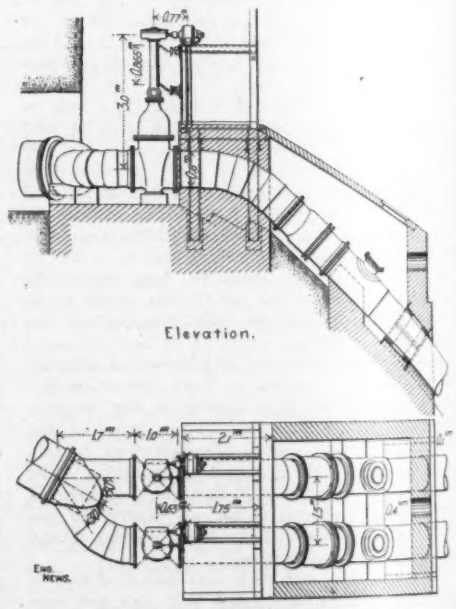

Fig. 2. Branch Pipes at Isola Station.

The constructing engineers determined, how-

ever, to utilize the fall in one step, in spite of the relatively large volume of water and the high velocity necessary in the pipes, and they were influenced in their decision to no small extent by the excellent character of the Lago d'Arno water, which is clear as crystal and makes any settling wholly unnecessary. Perfect clearness of the water is an important point under the conditions which obtain here, since the wear of turbine parts, in contact with water at

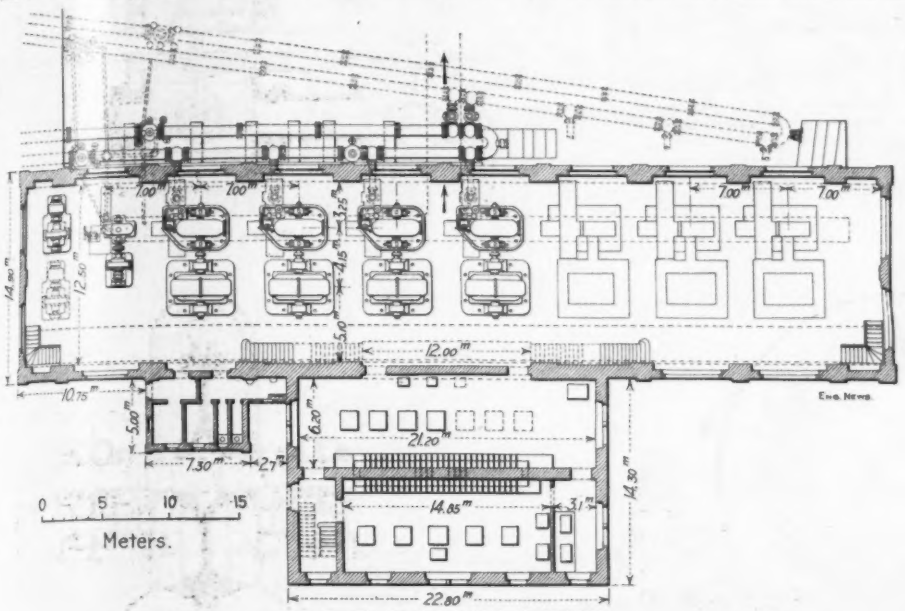

FIG. 3. PLAN OF ISOLA STATION.

this pressure carrying even a very slight percentage of suspended matter, increases very nearly as the square of the velocity and is apt to lead to serious interruptions of service.

On one hand, in order to keep the water section of a pipe line as large as possible and thus to reduce to the lowest limits the loss of head which increases as the square of the velocity, and, on the other hand to avoid too great a thickness of pipe and difficulty in the joints, it is often advisable to use a single pipe down to a certain pipe thickness, and then to divide by means of a breeches pipe, the two lines having together the same cross section as the single pipe. This arrangement, says Mr. Zodel, was carefully worked out for the present case, but was abandoned, principally on account of the difficulty in making the breeches pipe and of the necessity of providing this with stop valves. It was therefore decided to lay two separate and parallel pipe lines from the penstock chamber to the Isola power-house. When the works are enlarged to the final dimensions, a further pair of pipes will be laid. Each line is only intended to deliver 1 cu. m. (35.3 cu. ft.) per sec.; this gives a velocity of only 2 m. (6.6 ft.) per sec. in the largest pipes of 800 mm. (31.5 ins.) diam., and about 4 m. (13.2 ft.) per sec. as the greatest normal velocity in the smallest pipes of 556 mm. (22 ins.) diam. near the power-house. The conditions existing represent a loss in head of about 24 m. (79 ft.), or approximately 2.6%. The thickness of the lowest pipes, which have to stand a static pressure of 930 m. (3,050 ft.) reach 32 mm. (1.26 ins.), a thickness which in European practice it has been found just possible to weld satisfactorily by the oxy-hydrogen process.

The pipe line is divided by eight anchorages into seven inclined portions, to which must be added the horizontal distributing pipes along the power house. The pipe line passes through several tunnels. Two separate tunnels are provided for the two pairs of pipes, and cross levels a little over 6 m. (19.6 ft.) wide have been broken through the dividing walls at intervals of 20 m. (66 ft.) for delivering the pipes of the second pair of lines from the trolley way when these additional lines are finally erected. The line of the pipe bed was chosen with a view to covering in the pipes with earth to a depth of 2 m. (6.6 ft.) after the starting up of the works. This is necessary to prevent freezing of the water in the pipes, since the station is, as has been already mentioned, usually under load for only eight hours of the day, and it is naturally impossible, from the very character of the works, to allow water to flow for the remaining 16 or more hours, during which the plant is idle.

The top section of the pipe line, down to the point where the static head reaches about 220 m. (722 ft.) consists of riveted pipes of 800 mm. (31.5 ins.) diameter, and 7 to 14 mm. (0.28 to 0.55 ins.) thickness. They were made in 6-m. (19.7-ft.) lengths in the works, and the circular joints riveted together on the site. For the lower portions of the line, pipes of the same length lap-welded by oxy-hydrogen process, were used. These pipes were connected by overlapped double-riveted sleeve joints, capable of withstanding a pressure head of 570 m. (1,870 ft.). A final part of the line down to the power house was provided with flange joints. These are a welded-on flange end with a recess containing a wedge-shaped groove to receive round rubber packing. The two ends are pressed together by loose flange rings. Before carrying out the work, Escher, Wyss & Cie, repeatedly tested one of the pipes with this flange joint in the Weissholz welding works, near Düsseldorf, which supplied the welded pipes, to a pressure of 4,000 lbs., that is to about three times the working pressure, with perfectly satisfactory results.

The pipe material used was the best open-hearth fire box steel plate, having a tensile strength of 46,000 to 51,000 lbs. per sq. in. and 30% average elongation. This plate gave a high quality coefficient of 65 to 70, whereas the accepted standard for such boiler plate is 62. All pipes were tested in the shops to 1½ times the working pressure and kept at this pressure for one hour, during which the weld joint was thoroughly hammered. Any pipe showing signs of sweating was rejected.

The effective length of the pipes had to be limited to 6 m. on account of the great difficulties of transport. Fig. 1 shows the branch piece of the first pair of pipes with their valves and valve house at the end of the tunnel; a similar connection will be made for the two pipe lines to be erected later. These sluice valves are electrically driven and are controlled from the power house; the motors switch off automatically when the end position is reached. Expansion joints, with stuffing box packing, are used below each anchorage in the usual manner.

Especial care had to be taken in the design and construction of the distributing pipes connecting to the power house. Both pipelines are laid alongside each other as far as the middle of power house wall (Fig. 3), where they are joined together by a semi-circular bend, so that the lower turbines are fed from the second pipe line around this bend. It will be seen from the plan and section of the Isola station, Figs. 3 and 4, that sluice valves are arranged in such a way as to enable either pipe line to be closed at any time and the turbines to be run from the other. These valves are hydraulically operated.

The flange bolts of the horizontal pipes near the power house have to withstand a remarkable stress, since the hydrostatic pressure acting on the cross section of the two pipes produces a tension of not less than 280 tons. A partial relief was provided for these joints, without interfering with their longitudinal motion during contraction and expansion, by having a hydraulic piston acting on the semi-circular bend from the last masonry foundation block at the end of the pipe line. The cylinder behind the plunger is always in connection with the pressure pipes, and thus carries a pressure of 930 m. (3,050 ft.) head to oppose the load on the flange joints. The resulting relief amounts to about 61 tons. The semi-circular bends and the spherical T-pieces which connect to the turbines are steel castings. The third and fourth pipe lines will be arranged in a similar way when they are laid, and will be connected to the second and first, as shown in Fig. 3. Upon completion of the erection, each pipe line was filled with water and tested by pumps to 1½ times working pressure; they were perfectly rigid and water-tight.

TURBINES.—From the distributing pipe the water flows to each turbine through a pipe of 350 mm. (13.8 ins.) diameter to which is connected a hydraulically operated sluice valve of especially heavy construction. The water then passes through a bend to a needle nozzle of circular cross section, from which it emerges as a cylindrical jet on the wheel. A pear-shaped needle (see Fig. 5), which is movable along the axis of the nozzle, regulates the area of the opening

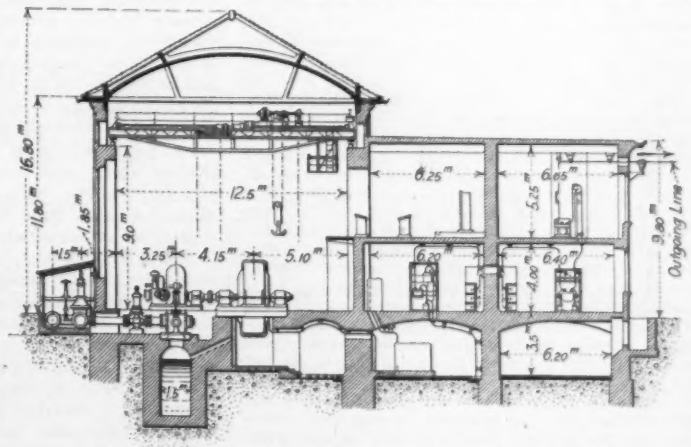

FIG. 4. SECTIONAL ELEVATION OF ISOLA STATION.

and the quantity of water required for the load on the turbine. The whole inlet bend carrying the needle nozzle is movable about the axis of the inlet pipe, in which it is pivoted. By swinging the nozzle in the vertical plane, it is possible to adjust the direction of the jet so that it hits the buckets accurately at one end of its swing but at the other misses the runner entirely and shoots straight down into the tail race. This deflecting nozzle, was designed by Mr. Zodel, and he has described it substantially as follows:

The nozzle is connected with the automatic governor in such a way that it swings out immedi-

ately any considerable reduction of turbine load occurs, without altering the setting of the needle and therefore without causing any shocks in the pipes. The automatic regulating gear then begins to shove the needle slowly forward and at the same time swings back the nozzle. When the latter has again reached its first position, the movement of the governor is completed and a fresh condition of equilibrium is established. The closing time of the needle nozzle can be adjusted within wide limits to suit the conditions of any plant.

A momentary loss of water, depending on the time of closing selected for the particular case, is of course unavoidable, just as in the case of the auxiliary outlet and the jet deflector. But the great advantage of the deflecting nozzle over other pressure regulators lies in the fact that nozzle and regulator are combined in one and that no wear or derangement of deflecting parts can occur, no matter how suddenly the mechnism is worked. By its use also, all continuous loss of water through leakage is avoided, and this is of very great importance for a high pressure plant of the present kind where storage is an essential factor.

The main object of the device, to avoid pressure shocks on a sudden switching off of the load, is fulfilled in an ideal manner, for the conditions of flow of the water through the nozzle are not altered by its being swung from the wheel. The resulting slight change in direction of the reaction from the jet is taken up by the ample bearings with which the inlet bend is pivoted in the inlet pipe; the oil pressure regulator has only to overcome the friction of the movable part in the inlet pipe, mainly caused by the pressure of the leather packing rings and by the force of reaction of the water jet.

The automatic oil regulator proper is of Escher-Wyss standard type and works with an oil pressure of 225 lbs. But the method of connection used between it and the deflecting nozzle on the one hand, and the regulating needle on the other, is new and characteristic. The connection with the deflecting nozzle (Fig. 5) is not rigid, but has an oil dash-pot with adjustable oil diaphragm interposed. For small load variations, the movements of the regulating gear are transmitted to the needle only, and are compensated by the passage of the oil through the dash pot, so that the nozzle itself remains steady and in its normal position. Should the closing movement of the gear be so sudden and the stroke so long, and should the corresponding lift of the piston of the dash pot cylinder be so great that the oil could not flow through the diaphragm with sufficient velocity from the upper to the lower end of the cylinder, then the dash pot is lifted, the connecting rod of the deflecting nozzle is raised in a like proportion by a servomotor, and the jet is deflected off the wheel. The levers of the regulator needle gear are so arranged that this gear follows the motion of the nozzle without being itself affected thereby; that is, the position of the needle is independent of the swing of the nozzle.

The character of the load on this power station is such that the nozzle need not swing out very often; this was desired in order to economize water. The mass of the rotating parts was therefore made large, so that, within a fairly wide range, the governor might have time to fulfill its guarantee by slowly altering the position of the needle alone, and without affecting the position of the nozzle, except for violent fluctuations of load.

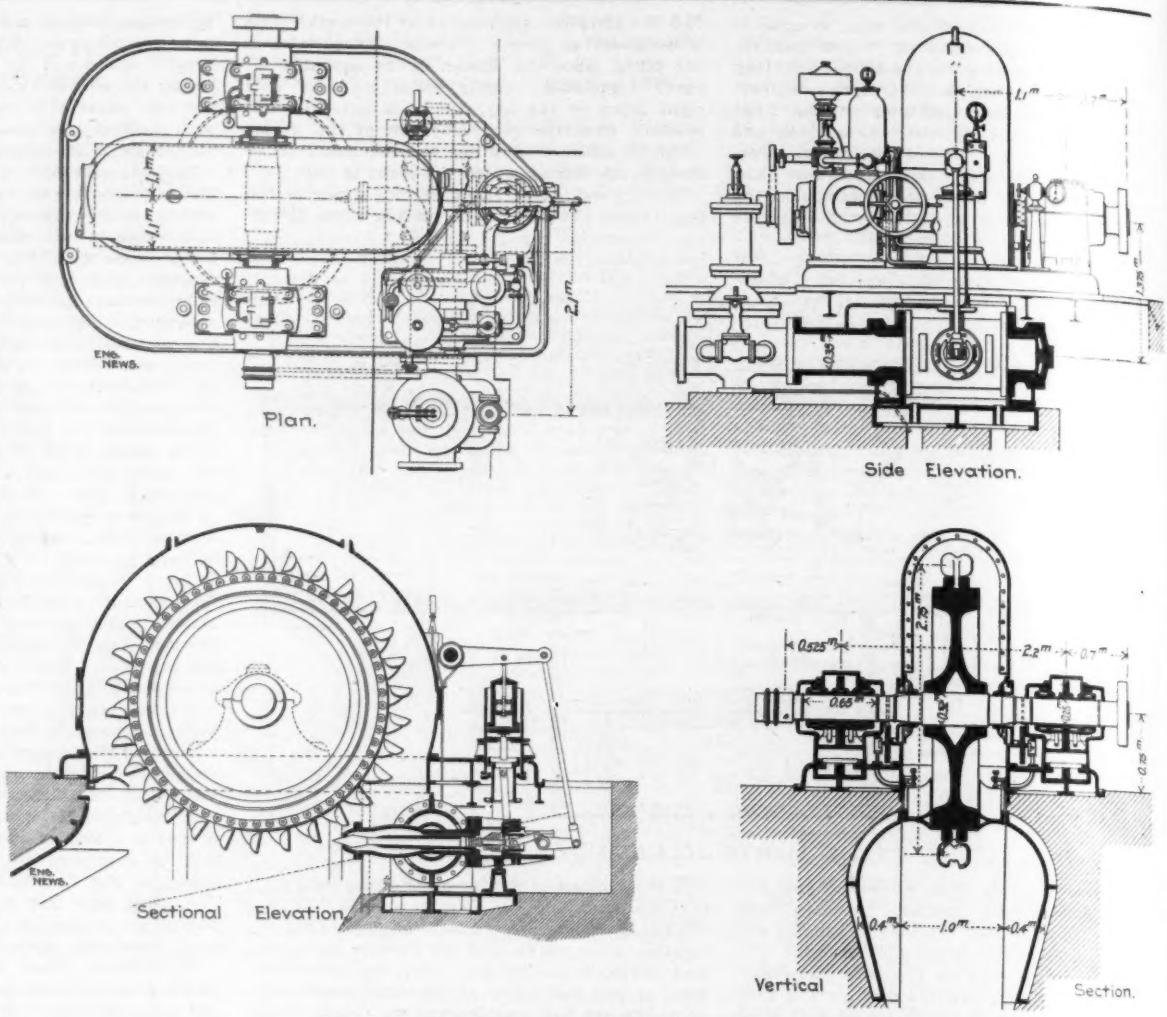

FIG. 5. THE 2,985-FT. HEAD IMPULSE WHEELS AT ISOLA.

The buckets are dovetailed into the wheel, and are each secured by two threaded bolts. The turbine shaft runs in two massive bearings bolted to the main bed plate, which also carries the governor, the casing, and the dash pot of the pressure regulator. The jet does not shoot directly into the tail-race when deflected off the wheel, but impinges at a small angle on an armored plate which turns it downward. The lateral discharge from the buckets is also caught by trough-shaped armor plates and turned harmlessly down into the tail-race.

The Isola station is laid out for seven main turbine units, each rated at 6,000 HP., for 420 r. p. m., together with an exciter set of 500 HP. Whatever may have been said about the difficulties of construction of the pipe line owing to the high pressure, or about the importance of ensuring the smallest possible loss of head in it, applies with greater force to the turbines.

A single jet was chosen as the most suitable for these machines, on account of the greater simplicity of the inlet pipes. The jet diameter is about 80 mm. (3.15 in.), and it has a spouting velocity from the nozzle of 135 m. (443 ft.) per sec. It is evident that even the very best materials can resist such a jet as this only if the latter impinges on the buckets without shock, and is deflected by them in a perfectly smooth and steady curve. Especial care was, therefore, necessary to safeguard the parts against rapid wear and to insure a high efficiency. The question of regulation has also had to receive close attention, so that no great rise of pressure should occur, on sudden variations of generator load, in a pipe line which was already highly stressed under normal conditions, and that there should at the same time be no waste of water to reduce the yearly output of the station.

It would have been an easy matter with this high fall to have built a wheel having a large number of revolutions and consequently small dimensions and light weight. But the necessity in this case of providing for minimum efficiency required a wheel of large size; hence the comparatively slow speed of 420 r. p. m. was selected. The runner has, thus, an outside diameter of about 3 m. (9.9 ft.); the very favorable ratio between wheel diameter and size of jet of 80:3000 = 2:75 resulted. It was also possible to choose a large pitch for the buckets, thereby ensuring a uniform deflection of the water jet.

In order to obtain a large fly-wheel effect for the group and, therefore, small moving velocities of the regulating mechanism, the turbine runner itself was built as a fly-wheel with a

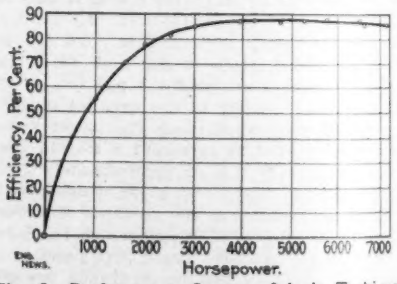

Fig. 6. Performance Curves of Isola Turbines.

heavy rim. Although a rather longer time of closing is thus possible, 5 to 6 seconds, yet this would be much too brief to prevent serious rises in pressure in the pipe line, and to avoid this the deflecting nozzle, above described, was chosen in preference to other devices, such as a jet deflector or an auxiliary outlet pressure regulator, owing to the greater wear which the use of these would occasion.

As it was considered very important to be able, at times, to put heavy overloads on the turbines and yet to obtain the highest possible efficiency

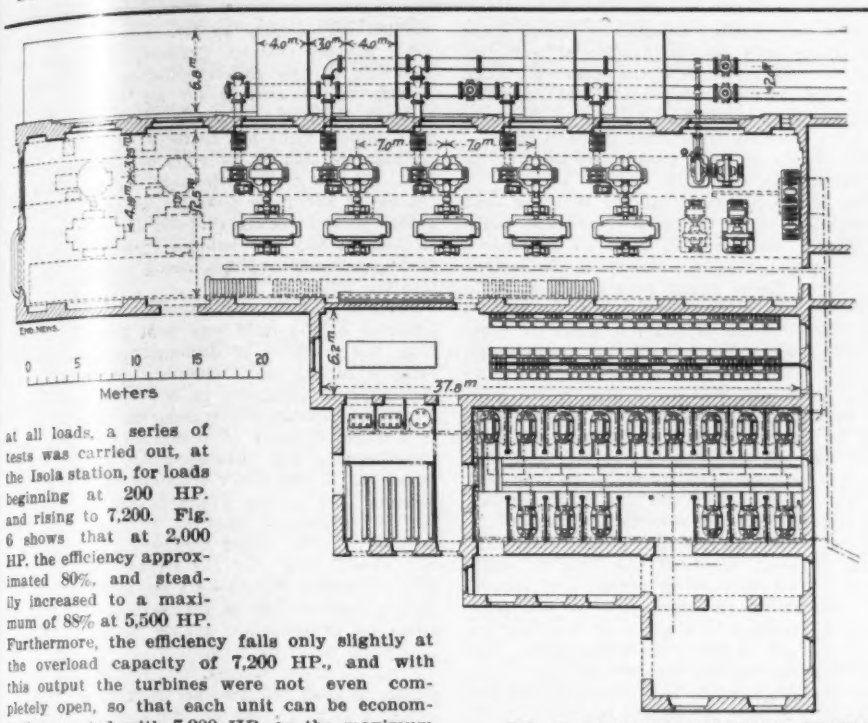

FIG. 7. PLAN OF CEDEGOLO STATION.

at all loads, a series of tests was carried out, at the Isola station, for loads beginning at 200 HP. and rising to 7,200. Fig. 6 shows that at 2,000 HP. the efficiency approximated 80%, and steadily increased to a maximum of 88% at 5,500 HP. Furthermore, the efficiency falls only slightly at the overload capacity of 7,200 HP., and with this output the turbines were not even completely open, so that each unit can be economically operated with 7,200 HP. as the maximum normal load, instead of at the rated capacity of 6,000 HP.

ISOLA STATION.—Each of the main turbines is direct connected to a three-phase, 40-cycle, 12,000-volt generator, built by Brown, Boveri & Co., of Baden, Switzerland. Current is delivered at that terminal pressure to transformers at the Cedegolo station, where it is raised to 60,000 volts for transmission to Milan. The electrical arrangement of the plant is, therefore, very simple. The only auxiliary of importance is a rotary-converter set of 500 HP. which serves as a reserve for the exciter unit.

The power house, which has interior dimensions of 63 × 12½ m. (207 × 41 ft.), lies close against the mountain slope, and on the right bank of the Poja d'Arno, the natural outflow from the Lago d'Arno. The tail-race passes under the turbines; its outlet being at right angles, about in the middle of the power house, beneath the distributing pipes; it then turns to the right and widens to form a measuring channel and overflowing weir. A junction is affected, immediately below this weir, with the conduit which carries the water from the Poglia (Adamè) and Salarno rivers to the Cedegolo station.

The Cedegolo Station.

The lower works of the Adamello power development, as stated in describing the Isola plant, were designed to take the combined flow of the discharge from that station, the diversion through a conduit from the Salarno River, the water from the main stream of the Poglia River, known at this point as the Adamè, and also the overflow from the Lago d'Arno through its natural outlet, the Poja d'Arno.

The water-race, 4½ kilos. (2.8 miles) long, leading to the lower power works, is partly conduit and partly tunnel; a trolley line runs alongside it, up which the building materials, pipes, and the machines for the Isola station were hauled by a gasoline locomotive. There is an overflow and waste sluice at about the middle of the race. A balancing reservoir of 26,000 cu. m. (917,800 cu. ft.) capacity adjoins the penstock chamber of the Cedegolo station, and is thus able, in case of need, to independently supply the turbines with 3.7 cu. m. (131 cu. ft.) per sec. for two hours. As the reservoir is constructed on the side of a rather steep slope, it was necessary for economical reasons so to plan the retaining wall on the valley side that the reservoir could be made as narrow as possible in the direction of the slope. A wall of the usual triangular section would have occupied a considerable amount of the available useful width, unless it was built so far out that the height and breadth of base required became impossible. It was, therefore, decided to construct a hollow wall in reinforced concrete, consisting of a succession of box-shaped cells, which were open in the water side, and received the necessary weight for stability from the water contained in them. A double purpose is served by this arrangement, as the retaining wall itself becomes very light and cheap, with an actual wall thickness of only 15 to 40 cm. (5.9 to 15.8 ins). It is exceedingly economical in space, since the three tiers of cells, each measuring 3 × 4 × 2.35 m. (9.9 × 13.1 × 7.7 ft.) internally, represent a useful water storage volume of about 4,000 cu. m. (141,000 cu. ft.). The wall is so designed that each section of cells is perfectly stable in itself, disregarding any lateral stiffness due to the construction as a whole. It does not rest on bed rock at all points, but is partly supported by arches having a span of from 5 to 8 m. (16.4 to 26.2 ft.) over small pockets with suitable fillings to prevent seepage. The total length of the wall is 130 m. (426 ft.) and the average length of the balancing reservoir is 7.35 m. (24.1 ft.). An internal coating of cement plaster spread over fine wire gauze was used to make the cells watertight. Expansion devices, which were originally provided for, were not used. The few small cracks, five in all, which developed during the extreme winter cold after completion of the reservoir, were filled with an elastic tar compound. This repair has been very satisfactory, as neither loss of water nor further cracks have since been observed.

From the penstock chamber, two pipe lines each of 1,000 mm. (39.4 ins.) diameter (a third to be provided later) descend in a straight line to the Cedegolo power house, on the left bank of the Oglio. The generating room contains five 4,500-HP. hydraulic turbines, and a 500-HP. exciter, built in the shops of A. Riva & Cie., of Milan; the main turbines are coupled to three-phase, 40-cycle, 12,000-volt, 420-r. p. m. generators. This central station contains a large switching and transformer plant, where the current is stepped up to 60,000 volts for the long-distance transmission system. The voltage will be raised later, on completion of the entire Adamello project, to 72,000 volts.

There are 15 single-phase oil-filled water-cooled 2,700-KVA. transformers, in two rows of separate cells in the back of the station.

The central part of the building is occupied by the switch gear, which is so designed that it can combine for transmission the energy generated in this station with that supplied from the Isola station. The apparatus occupies the basement and four stories. The 12,000-volt bus-bars are on the ground floor, with the oil switches for the generating units on the first floor above, the 60,000 volt bus-bars and line switches on the second and the lightning arresters on the third, as partially shown by the sectional elevation of Fig. 8. The protective apparatus at the top provides for both the outgoing lines and those coming in from Isola.

The single-phase cables coming from the alternators are laid in a spacious underground passage and run into the 12,000-volt bus-bar chamber, where they are connected to the oil switches. The switches are three-phase, with instantaneous release, and break the circuit in an oil bath at two different points for each phase. Switching in or out may be effected either manually or electrically.

The three phases pass through the circuit breakers and isolating switches and are then taken to the 12,000-volt bus-bars, separated by concrete partitions. As two working systems

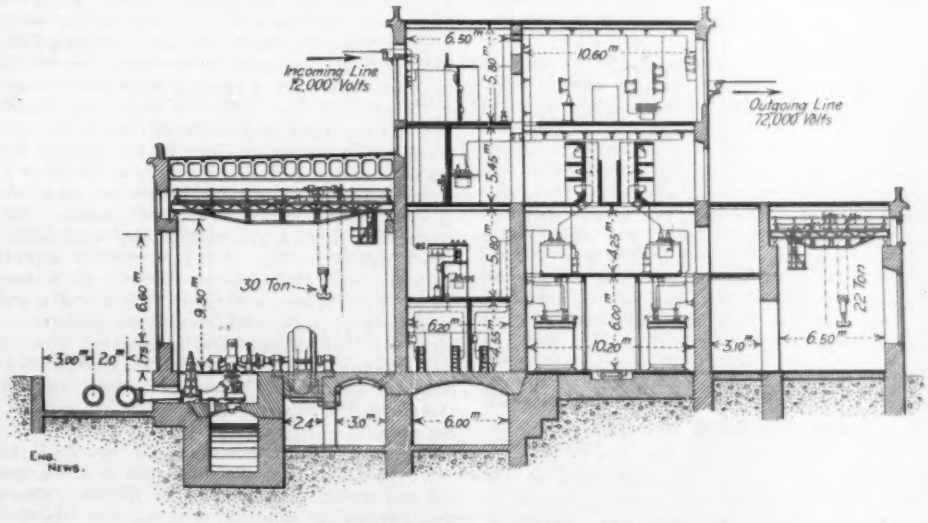

FIG. 8. SECTIONAL ELEVATION OF CEDEGOLO STATION.

are required for the station, two sets of bus-bars are provided, which, if necessary, can be connected to form ring mains. From the bus-bars the connections rise to the first floor above after passing through the 12,000-volt transformer oil switches, which are mechanically connected to the corresponding switches for the 60,000-volt side, so that any transformer can be completely isolated in one operation. The connections next pass to the 60,000-volt bus-bars on the second floor above, then are taken through the line switches and finally to the lighting arresters and outgoing cables. On the top floor, but on the opposite side, four 12,000-volt lines

from Isola enter the building, and the regulation for parallel operation of the two stations is carried out on that voltage side.

For the current used in the plant itself and vicinity there are two three-phase oil-filled water-cooled transformers, only one of which is used, the other being held in reserve. Here current from the 12,000-volt bus-bars is stepped down to 220 volts. The whole of the installation is controlled from three benchboards on a raised platform, one for the generators, one for the transformers and one for the lines. The auxiliaries are controlled from a vertical 12-panel switchboard on the generator floor. For these particulars relating to the high-tension system at Cedegolo, the writer is indebted to the Allgemeines Elektricitats Gesellschaft, of Berlin, which supplied the equipment.

The high-tension system of the 120-kilo. (74.6-mile) transmission to Milan, intended on final completion to consist of four lines of three wires each, at present consists of two lines each carried on separate towers. The two lines are 12 m. (39.4 ft.) apart; the normal height of the steel towers is about 20 m. (65.6 ft.) and the normal span between them is 185 m. (607 ft.). The latter is, in places, increased to 200 m. (656 ft.). No high-voltage lines have been built in Italy for some years with a distance between the poles less than 120 m. (394 ft.). Experience shows that in spite of their greater height and strength the smaller number of towers and the fewer insulators on this line give a very considerable saving over the older arrangement with shorter spans.

The Adamello works were commenced in the beginning of 1908. The Cedegolo station was ready to furnish power early in January, 1910, while the upper Isola station has only been running since the beginning of November, 1910. If one considers, says Mr. Zodel, the enormous difficulties which had to be overcome in carrying out most of the work, the water intakes and the whole of the upper plant being almost inaccessible in winter, then the completion within this time must be acknowledged to be a work which could only be possible with the most capable management, perfect organization, and with the help of all the means that modern engineering skill can command.

The first thing to be undertaken was the erection of a small plant of 300 HP. on the Salarno, near the village of Fresine, from which power mains were spread over the whole of the construction system. Over 60 motors were in operation, for hoisting and lifting machinery of all kinds, and for driving pumps, air compressors, etc. The management was entrusted to Engineer Vovi, of Milan, General Director of the Società Generale Elettrica, who had already become well known through the power developments at Paderno and Trezzo. The construction was under the management of Engineer Carminati, of Bergamo, and of his assistant engineer, Vassena. Engineer Roncalier of the Società Generale Elettrica was superintendent of electrical construction.

Recent Methods of Sewage Clarification and Sludge Treatment in Germany.

By E. KUICHLING, M. Am. Soc. C. E.*

The methods of clarifying and treating the sewage of cities are always of great interest to municipal engineers, and each new process is naturally subjected to the keenest scrutiny and criticism by those who have adopted some different process. As the whole subject is still somewhat obscure, in view of the extreme complexity of its physical and biological details, it follows that real progress in this difficult art can be attained only by long-continued experiments on a much larger scale than is possible in a laboratory or experiment station, and that much can be learned from the criticisms of those who are actively engaged in the operation of large municipal plants. Much has been published during the past two years in regard to the conspicuous success of the so-called Emscher or Imhoff tanks in connection with the clarification of municipal sewage and the treatment of the resulting sludge, and as this type of construction and operation has not yet been applied on a large scale in our country, it becomes of interest to learn some of the criticisms that have been made upon it recently by foreign engineers.

It will be remembered that the Emscher tank is a modification of the deep cylindrical tanks with conical bottoms first built at Dortmund, Germany, about 1888, for clarifying the sewage of that city. These tanks were about 30 ft. in diameter and 33 ft. in depth below the surface of the liquid therein, which was admitted from a descending vertical pipe about 3 ft. in diameter, terminating about 13 ft. above the apex of the conical bottom, and was distributed in the horizontal section of the cylinder by means of a number of horizontal arms shaped like inverted troughs radiating from the end of the pipe. The quantity of sewage admitted to each tank was at the rate of about 2,500,000 U. S. gals. per day, so as to make an upward velocity of about 0.07-in. per sec. in the cylindrical part of the tank, thus affording a period of about one hour for sedimentation. The sediment or sludge accumulated in the conical bottom was removed therefrom at times by pumping with a 4-in. or 5-in. suction pipe. It was also noticed that if the sludge was allowed to remain in the tank for several weeks it would undergo more or less decomposition and become much denser or contain less water than when newly deposited. This important quality of the sludge, however, was not fully recognized or appreciated at first, especially because the evolution of gas in the tank tended to render the effluent turbid and malodorous, and thus led to the discharge of the sludge at frequent intervals. It may also be remarked that the cylindrical form was used, because it required the least quantity of brickwork to resist the lateral pressure of the soil, which is often saturated with water at such a depth below the surface.

The troublesome and expensive disposal of both freshly deposited sludge and such as had become putrescent by storage in separate tanks or lagoons, together with the recognition of some of the advantages that would be gained by allowing the sludge to become thoroughly decomposed before removal, gradually led to the development in England of a number of septic tanks. The principle governing their design was to provide storage capacity for the entire volume of sewage delivered in from 12 to 24 hours, thereby permitting the liquid to flow very slowly through the tank and to deposit all of its suspended matters before reaching the outlet. The organic matter in the sediment was expected to undergo decomposition rapidly, and thus be transformed mostly into soluble and gaseous compounds, leaving on the bottom only a comparatively small quantity of non-putrescible organic material and the mineral matter. This final sludge would contain but little water and might be thrown upon the land without becoming offensive. For the effluent which contained more or less organic matter in solution, further purification was provided by means of either irrigation, intermittent filtration, contact beds or percolating beds.

The septic tanks, however, did not fulfil all expectations, as the chief objection to them was the putrescent condition of the effluent, which also carried in solution some of the offensive gaseous products of decomposition. A means of securing a tank effluent free from such gases was next sought, and the problem was finally solved to large extent by Dr. W. O. Travis, of Hampton, England, by dividing a deep septic tank into an upper and a lower chamber, with slots in the bottom of the small upper chamber through which the fresh sludge deposited therein from the slowly moving sewage might drop into the lower chamber, in which the liquid was nearly stagnant, as only a fraction of the volume of sewage was permitted to flow through the same. The results proved to be very satisfactory and attracted much attention, especially from German engineers. The operation of the plant was studied very closely by Dr. Imhoff, of the Emscher Sewage District, Germany, and after considerable further experimentation he decided to modify it by cutting off all flow of sewage through the lower or septic chamber and securing ample ventilation therefor by large vertical passages formed on the sides of the upper chamber. He also gave much attention to shaping the bottom of the upper chamber, so as to allow the sludge to slide easily through the slot and also to prevent any gas bubbles from the sludge in the lower chamber from rising through the slot into the upper chamber.

In this manner the effluent from the upper chamber of the tank was kept from admixture with the products of decomposition continually forming in the septic chamber underneath, and was thus in condition to be discharged into a stream of suitable size, without causing the water to become offensive or poisonous to the animal life therein. The decomposition of the sludge proceeded in the lower chamber to a stage depending only on the available storage capacity, and the remaining question of importance was in regard to the proper magnitude of this chamber, or the length of the storage period. Few data pertaining thereto were accessible, and hence careful observations in this direction had to be made on experimental plants before a reliable conclusion could be formed.

From all these studies, Dr. Imhoff finally designed, in 1906, the Emscher tank in the form in which it is now used by the Emscher Association at all of its sewage-disposal plants. The first plant was built during the same year at Recklinghausen, which was then a city of about 25,000 inhabitants. It consists of six such tanks, combined into two groups of three each, placed side by side, and was put in service in February, 1907. Its successful operation led to the construction of similar but much larger plants at Essen N. W. and Bochum in 1908. Despite considerable overworking in consequence of an unexpectedly rapid increase of population, all of these plants have continued to give the most satisfactory results, as exhibited in the reports of the chemist of the association, Dr. Ingr. Spilliner, published in Heft. 14, "Mit. d. Königl. Prüfungsanstalt," Berlin, 1910, and "Technisches Gemeindeblatt," Vol. 13, 1910-11, pp. 313-377.

The first-mentioned report has been translated by Mr. Kenneth Allen, Chief Engineer of the Metropolitan Sewerage Commission of New York, and the writer has translated the most interesting portion of the second paper, which was prepared to supplement the first report. It is expected that these two translations will appear in book form early in 1912. Abstracts of a later report by Mr. Blunk, one of the managing engineers of the Emscher Association, and of discussions of this subject by other German writers are in preparation by the present writer.

Shallow Rectangular Sedimentation Tanks, With Hopper-Shaped Bottoms, at Elberfeld, Germany.

As already stated, the new sewage-disposal plants in the Emscher district soon attracted many visitors interested in the subject, and the results of their operation have been compared closely with the performances of other large municipal plants built recently on other lines. The first important criticism was made by Mr. Schönfelder, City Engineer of Elberfeld (which is only about 15 miles south of Essen and Bochum), in a paper read at the convention of municipal engineers held in that city on Sept. 13, 1910. This paper is published in "Technisches Gemeindeblatt" for Oct. 20 and Nov. 5, 1910, Vol. 13, pp. 209 and 225, and sets forth the merits of the relatively shallow sedimentation tanks that were built at Elberfeld under his direction in 1907. These rectangular tanks are each 131 ft. long, 21 ft. wide and contain a depth of sewage of 8.5 ft. above the level of the upper edges of the series of four hoppers of varying depth that form the bottom; the deepest hopper, 13.8 ft. in depth from the surface of the liquid, is next to the inlet, and the shallowest, 10.5 ft. in depth, is next to the outlet weir. Each hopper is provided with an

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outlet pipe for removing the accumulated sludge from time to time.

This arrangement of the bottom was chosen to conform to the quantities of four different grades of sedimentable matter in the sewage, and also to the average distance traveled by each grade in the course of settling through the slowly moving mass of liquid. It is well known that the heavier matter will settle quicker than the lighter, and will accordingly travel a shorter distance in a slow current; and it has also been found by experience that the quantity of heavy matter in sewage is much larger than that of the lightest sludge. There is likewise an appreciable difference in the quality of the different grades, the fatty matter generally being the lightest, and therefore tending to settle mostly in the hoppers nearest to the outlet. The fatty matter, moreover, is undesirable in sludge that is to be used as fertilizer, while, on the other hand, it has a higher commercial value than any other substance that can now be extracted economically from the sludge. As it is probable that a profitable method of extracting this fat will soon be devised, it becomes expedient to provide the raw material in the most concentrated condition practicable, and this is accomplished by arranging the hoppers as indicated. The same remarks apply equally to processes for producing ammonia and gases for heating or power, etc., from sludge, in both of which directions encouraging experiments have recently been made.

It is therefore of primary importance to design the sedimentation tank so as to insure a uniform slow velocity throughout its entire length, and to avoid changes in direction of flow and the formation of eddies as much as possible. If such changes occur, the lighter matters cannot reach the bottom unless the length of the tank is correspondingly increased. From the various exhaustive experiments that have been made in recent years at Cologne, Hanover and Elberfeld, it was found that a practically complete sedimentation could not be secured in tanks of uniform cross-section, and with velocities of flow ranging from 1/6 to ½-in. per sec. when the length of the tank was less than 130 ft., corresponding to a time of from 1 to 3 hours for a particle of water to traverse this distance. These conditions are not obtained in the Emscher tanks as now constructed, since the cross-section of the waterway of the settling chambers is considerably contracted at the places where it passes through the cylindrical walls of the three tanks, and also because the length of uniform waterway across each cylinder is much too short. These defects might be remedied by placing four instead of two or three tanks in a row and modifying the manner of carrying the settling chamber through the cylindrical walls, but the cost would thereby be increased materially.

The Elberfeld tanks were designed with the view of removing the sludge from the hoppers through pipes by means of the pressure of the superincumbent liquid, as in the case of the Dortmund and Emscher tanks; but unlike the latter, it was intended to remove the sludge at frequent intervals, in order to avoid the destruction of much valuable organic matter by decomposition; and, incidentally, also to prevent the infection of the sewage and effluent by the products of such decomposition, as with the Emscher tank. The experience with the Elberfeld tanks has proved that this could be accomplished satisfactorily by making the bottom hoppers of different depths and capacities, as already described; and the only objection to this method of removal was that somewhat more water was mixed with the sludge than is desirable. Efforts were then made to devise a means of determining the right moment to close the valves of the sludge pipes, so as to retain the watery strata after the denser mass had been discharged. This was finally done by means of submerged floats, which would sink in water but would be supported on the surface of sludge of suitable density, as it was found by elaborate experiments that this sludge maintained a horizontal surface in a properly-shaped hopper while it was being drawn off.

These experiments were made in model which afforded a prism of sewage 6.6 ft. deep, 3.3 ft. wide and 1.6 ft. thick, the broad face being formed by a thick plate of glass through which the process of sedimentation could be observed closely. A pipe and stop-cock in the bottom of this model permitted the sludge to be removed at any desired rate and time, and a hopper was formed in the lower part thereof by two metallic plates 1.6 ft. wide, and of different lengths, set at varying angles against the vertical sides. By this means the proper slopes were determined which would allow the dense sludge of different age and quality to slide down the sides of the hopper and still preserve its horizontal surface while the lower portion was being discharged through the pipe. The author does not state his conclusions definitely in this respect, but it can be inferred from the photographs printed in the paper that these slopes should be somewhat steeper than 1 to 1 for both coarse-grained and fine-grained sludge.

Particular attention is called to the fact that in all these experiments, the surface of the sludge was perfectly horizontal soon after the sewage became quiescent, and that the same also occurs in the large tanks used in practice. This was first pointed out by Mr. Schönfelder in Heft. 8, Mit. d. Königl. Prüfungsanstalt, Berlin, 1907, in a paper on the process of sedimentation, in which it was shown that a constant vertical circulation of the water takes place, the descending particles of sludge displacing equal volumes of water at the bottom and thus causing these lighter volumes of water to rise to the surface. As most of the sedimentable matter is distributed uniformly throughout the sewage while in relatively rapid motion in the sewer, it will also settle uniformly, according to its specific gravity and size, when the liquid becomes nearly quiescent in a large tank, and will assume a horizontal surface in a hopper with steeply sloping sides.

The experiments also showed that when the sides of the hopper were less steeply inclined (45° or flatter), the surface of sludge over the outlet pipe would soon exhibit a depression, especially if the stopcock was opened suddenly to full extent; and that this depression would gradually increase unless the discharge were reduced, in which event the surface soon again became horizontal. This indicates that the sludge pipes should not be opened quickly, and that due vigilance must be exercised while the hoppers are being emptied, in order to avoid diluting the sludge needlessly. It may also happen that if left too long in a hopper, the sludge will become so thick that it will not flow readily through the outlet pipe. This is likely to occur when the sewage carries much sand or grit and clayey matter from storm water, and hence it is highly important to extract all such material, as well as all coarse matter, from the sewage by means of a suitable detritus tank and screen, before allowing it to flow into a sedimenting tank.

In regard to the character of the wet sludge obtained from the hoppers of the Elberfeld tanks the following averages of analyses made of 32 samples taken from four tanks on Dec. 11 and 12, 1907, and Jan. 2 to 6, 1908, are submitted:

	Percentages for each hopper, beginning at inlet, and averages for the four hoppers.				
	I.	II.	III.	IV.	Average.
Max. contents of water.	91.24	91.15	92.72	93.24	
Min. contents of water.	84.57	87.42	89.16	86.58	
Av. contents of water.	89.09	88.94	90.77	90.16	89.74
Max. dry matter.	15.43	12.58	10.84	13.42	
Min. dry matter.	8.76	8.85	7.28	7.76	
Av. dry matter.	10.91	11.06	9.23	9.84	10.26
Max. mineral matter.	3.53	4.57	3.36	5.38	
Min. mineral matter.	1.61	2.07	1.96	2.27	
Av. mineral matter.	2.35	3.32	2.88	3.42	3.30
Max. raw fats.	2.35	3.04	2.57	3.27	
Min. raw fats.	1.14	1.20	1.58	1.80	
Av. raw fats.	1.81	2.11	2.02	2.25	2.05
Max. fats in dry matter.	19.38	24.41	23.68	28.75	
Min. fats in dry matter.	10.39	12.99	17.28	16.77	
Av. fats in dry matter.	16.64	19.02	21.82	23.15	20.15

It will be noticed from the preceding table that the dried sludge contains an unusually large percentage of fatty matter, and also that this percentage increases with the distance of the sludge hoppers from the inlet end of the tank. The author asserts that the percentage of water in the comparatively fresh sludge of his tanks is as low as can possibly be obtained in any other plant; and as his paper immediately followed a description of the Emscher plants by Dr. Ingr. Imhoff at the said convention, this assertion must be regarded as implying that the low water content claimed for the decomposed liquid sludge from Emscher tanks is not always obtained. Perhaps this was not the author's intention, as the context refers to shallow tanks and to the old method of drawing off all the clarified liquid in a tank before removing the deposited sludge; hence it is possible that the assertion relates only to the new method of removing the sludge by the pressure of the superincumbent water.

In regard to the quantity of sludge obtained at the Elberfeld plant, the author states that a volume of 180 cu. m. (235.4 cu. yds.) of wet sludge containing about 92% water is deposited daily from the dry-weather flow of 44,500 cu. m. (11,766,000 U. S. gals.) of sewage per day. The volume of sludge is thus 0.4% of the volume of sewage, which agrees with the observations made formerly in English and German cities. This percentage is of interest, as it has been believed by many that sewage containing a large proportion of liquid industrial wastes, like that of Elberfeld, would not yield nearly as much sludge per unit of volume as purely domestic sewage, on which the older estimates were mostly based. The conclusion was reached here that the acids and alkalies of our industrial wastes cause a precipitation of much of the matter contained in the domestic sewage, and the same effect has been observed in numerous other cities.

The author then proceeds to estimate the number of Emscher tanks that would be required to deal with the aforesaid volume of 180 cu. m. of sludge per day, on the assumption of storage for about six months and a reduction in the amount of moisture in the wet sludge from 90% initially to about 85% after decomposition. He computes that such a plant would require 146 deep cylindrical tanks, each having a storage capacity of 166 cu. m., or an aggregate capacity of 24,236 cu. m. The method of arriving at this result is not given, but it is probably as follows: A volume of 180 cu. m. daily for 180 days makes an aggregate of 32,400 cu. m. of sludge containing 90% water; at the end of this time it will contain only 85% water, and its volume will be 10/15 of 32,400, or 21,600 cu. m., while the remaining 2,636 cu. m. is reserve capacity above the surface of the decomposed sludge. It will be noticed, however, that no allowance is made in this computation for loss of solid organic matter by gasification and liquefaction, and that a more exact method in combination with a considerably shorter storage period would result in a much smaller number of Emscher tanks.

The wet sludge from the Elberfeld tanks was formerly discharged into a number of lagoons or open basins, three of whose sides were formed of interwoven brush-work or fascines, to act as a rough filter and facilitate the separation of water from the liquid mass. As the soil was impermeable, this plan did not prove successful, the brush-work soon becoming clogged so that the water could not escape. At times it would be necessary to fill these basins to a depth of nearly 5 ft., whereby the mass never became dry enough to handle with a shovel. The method was then modified by forming the lagoons on permeable ground, with sides of better fascine work and better means of drainage. There are now 24 such open lagoons in use at Elberfeld, and they are never filled to a greater depth than 2.3 ft. The sludge attains a spadeable consistency, with from 71 to 78% moisture, in the course of a few months, when it is removed to other localities in the vicinity and spread out on the surface of the ground to undergo further decomposition. Eventually it becomes a compact earthy mass which can be used for embankments and dikes. Some of the moist sludge is taken away by farmers for use as fertilizer, and the remainder is applied with great success to the large tract of land owned by the city in the neighborhood of the plant. From the diagram showing the operation

of the lagoons or sludge basins, each appears to be used only once or twice a year. The area of the several basins is not given.

After some of the water in the liquid sludge has disappeared by drainage and evaporation, the mass acquires a jelly-like consistency and soon exhibits innumerable shrinkage cracks on the surface. These cracks rapidly increase in width and depth, thus multiplying the surface exposed to evaporation, and also allowing plenty of air to reach the interior in order to accelerate the oxidation or decomposition of the organic matter. Samples of the sludge that had remained four months in a lagoon were analyzed and compared with the spadeable sludge of the Recklinghausen plant, which represents an aggregate storage period of six months, the results being as follows:

	Percentages.	
Composition.	Recklinghausen sludge, 6 months old.	Elberfeld sludge, 4 months old.
Inorganic matter, residue after ignition	57.22	42.53
Organic matter, residue on ignition.	42.78	57.47
Raw fats	1.95	3.21
Nitrogen	0.747	0.494

These figures indicate no differences in composition that would not be eliminated by a somewhat longer exposure of the Elberfeld sludge in the lagoons; and hence it becomes evident that the mode of treating the sludge in the cheaply-built lagoons at Elberfeld is much less expensive than the mode of treatment by decomposition in costly Emscher tanks. No reference is made by the author, however, to the offensive odors that usually emanate from open sludge beds.

In regard to the action of the oxygen of the air and that which is dissolved in the rain water falling occasionally upon the exposed sludge, in promoting the decomposition of the organic matter, it is very difficult to reach a conclusion, as the opinions of scientists differ diametrically concerning it. One group of investigators contends that such decomposition must be attended with a constant flow of fresh water, while the other group insists that the admixture of fresh water with the decomposing matter is entirely unnecessary. The former opinion is represented in several recent English patents for methods of treating sewage, and the latter is expressed by the experts of the Emscher Association. At the present time this controversy still remains unsettled, and the author considers that the good results attained in the Elberfeld sludge lagoons fully corroborate the former opinion.

Mr. Schönfelder believes that a time will soon arrive when valuable commercial products will be extracted profitably from sewage sludge, and he is therefore opposed to the general use of Emscher tanks or other septic tanks in which the organic matter is permanently destroyed by putrefactive decomposition. He considers it far preferable to construct permanent sedimentation tanks that will yield the sludge in a fresh condition, and capable of being utilized advantageously for the extraction of fats and other valuable substances at some time in the near future, and meanwhile to treat the sludge by drying it to spadeable consistency in cheaply-built lagoons, as at Elberfeld. Should the advent of such profitable utilization be long delayed, a means of getting rid of accumulations of dried sludge is still available by burning them. He found that when this matter became thoroughly air-dried by exposure on open land, after removal from the lagoons, it could easily be ignited and would smoulder away like peat, leaving only a residue of powdery ashes. He also found from experiments at the refuse cremating plant in the neighboring city of Barmen, that if the amount of moisture in the sludge was reduced to 45%, which was attained by an inexpensive preliminary drying in a heated chamber, it could readily be burned in the furnaces without causing a reduction of temperature in the cremator, and that this result was accomplished whether the sludge was mixed with other fuel or not. With all these prospects, he felt confident that no mistake had been made in the method of treating the sewage of Elberfeld.

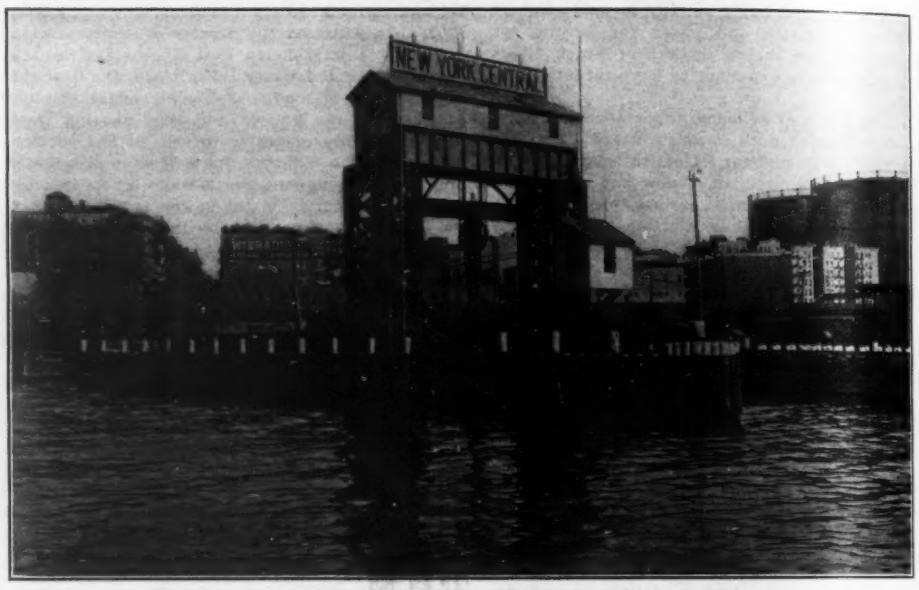
The 69th St. Car-Transfer Bridge of the New York Central & Hudson River R. R. at New York City.

Car-transfer bridges for transferring freight cars to and from car floats play an important part in freight movements in New York harbor. The large amount of freight-car floating across the Hudson and East Rivers has developed some specialized conditions in this harbor, so that the problem of constructing transfer bridges for service in New York is not necessarily identical with the general problem of such structures.

The tidal range, about 11 ft. from extreme low water to extreme high water, is less than met at some other railroad water terminals where car ferriage is required. The floats used throughout the harbor require to be sufficiently similar in their controlling points so that any float may be able to load or unload at any transfer bridge. The floats, while of moderate size compared with the large car-ferry steamers of the Great Lakes ferry lines, are large enough to call for careful provision of adequate strength in the bridges. Moreover, the vertical play of the floats, as strings of cars are run off or on, tends in combination with the weight and length of the boats to require either a very flexible bridge structure or great strength to resist the loads imposed by tilting movements of the vessel.

In a new transfer bridge recently installed by the New York Central & Hudson River R. R. at the foot of West 69th St., forming part of the float-bridge equipment of the 60th St. receiving yard of the railway, several problems have been dealt with in a rather new way. The new bridge presents distinctly novel features in the field, which its successful operation since it was put in service in March, 1911, has justified.

The bridge was designed by the Engineering Department of the N. Y. C. & H. R. R. Co., with the assistance of Mr. J. B. French, Consulting Engineer, New York City, former Bridge Engineer of the Long Island R. R. Co. The general arrangement of the structure was recommended by Mr. French as an improvement of the Long Island R. R. type, and the novel features of the inside aprons and the outboard supports for the same were originated and have been patented by him. Mr. A. W. Carpenter, Engineer of Structures, had charge of the design for the railroad company with the approval of Mr. J. W. Pfau, Engineer of Construction, and Mr. Geo. W. Kittredge, Chief Engineer.



FIGS. 1 AND 2. NEW TRANSFER BRIDGE OF THE NEW YORK CENTRAL & HUDSON RIVER R. R. ON THE HUDSON RIVER AT 69TH ST., NEW YORK CITY.

Transfer bridges of both the pontoon type and the suspended type are now in use in New York Harbor. The use of the old pontoon type has of late years, however, been steadily decreasing, largely due to the great increase in the weight of loaded cars handled, which has made necessary heavier and longer bridges and increased the difficulties of operation of this type to such an extent that the loss of time in operation is very serious. Ice troubles in winter and difficulties of maintenance have also militated against the use of the old pontoon type of transfer bridge.

The first suspended or hoist bridges used in the harbor were equipped with hinged sections (aprons) at the outshore end. These aprons were made sufficiently flexible transversely to accommodate themselves to the torsional strains produced by the listing or transverse changes in level of the floats. The hinges by which they were attached to the bridge enabled the aprons to follow the vertical movement of the float as cars were run on or off. Both the outshore end of the bridge and the outshore end of the apron were counterweighted for somewhat less than their dead weight, and two sets of hoisting machinery were provided, one for the bridge and the other for the outer end of the apron. The screws and overhead structure supporting the bridge were necessarily made strong enough to carry both dead and live load, but the overhead support provided for the outer end of the apron was designed to carry dead load only, leaving the live-load reaction due to cars passing over the apron to be carried by the float; and in these earlier bridges neither the machinery for lifting the bridge nor that for operating the apron was designed to move any part of the live load, its function being confined to the vertical adjustment of the bridge and its apron in their unloaded condition.

In 1903, the Pennsylvania R. R. built a group of transfer bridges at its Greenville yard, which, while following closely the early type of suspended bridge just described, went one step further and provided operating machinery for the main bridge sufficiently powerful to lift it at high speed while fully loaded with moving cars, and also provided extra counterweights and powerful machinery whereby that portion of the live load on the apron formerly carried by the float could be partly transferred to overhead supports at the will of the operator. Both the bridges and the aprons were made of wood and were double-track structures, each bridge having three wooden trusses and the aprons being single platforms continuous transversely under the two tracks. Since the completion of the Greenville bridges, the Pennsylvania R. R. has built a number of bridges of the same type elsewhere in the harbor. In 1909 the New York, New Haven and Hartford R. R. built a group of bridges at its Oak Point yard on the East River following substantially the Greenville plans, but substituting three steel plate-girders for the wooden trusses.

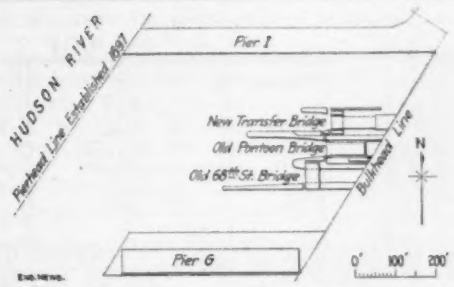


Fig. 3. Location Plan of New Transfer Bridge at 69th St.

Shortly after the Greenville bridges were built, two steel girder bridges of the suspended type were put in service by the Long Island Railroad in its yard on the East River at Long Island City, which differed both from the old type of suspended bridge and from the Greenville type just described, in the following particulars: (1) The double-track bridge was divided longitudinally into two single-track structures, each independently suspended from overhead girders and independently operated by a separate motor, only the overhead girders and their supporting steel towers being common to the two halves. (2) No aprons were used, but at the outshore end of each half-bridge a transverse rocking girder was provided, centrally pivoted on a 10-in. pin with longitudinal axis. This rocking girder carried the ends of the bridge track rails and the toggle or latch bars for attaching the bridge to the float, and by turning on the pivot pin it took up the warping and twisting movements of the float. (3) High-speed operating machinery was not used, and the connection between the screws and the suspending frames was, therefore, so designed that the suspending frame could freely slide upward on the screws and thus prevent injury to them or to the operating machinery by any upward movement of the bridge.

The new 69th St. bridge, shown by the views Figs. 1 and 2, and the general drawing Fig. 4, is in general a development of the Long Island R. R. structures just described. The essential differences are: The use of more powerful high-speed operating machinery, which is practically a duplicate of that in the N. Y., N. H. & H. R. R. Oak Point bridges, the substitution of flexible aprons, contained within and supported by the main bridge girders, for the transverse rocking girders and their supporting longitudinal pins; the provision of support for car floats; and the improvement of details.

The employment of aprons provides a satis-

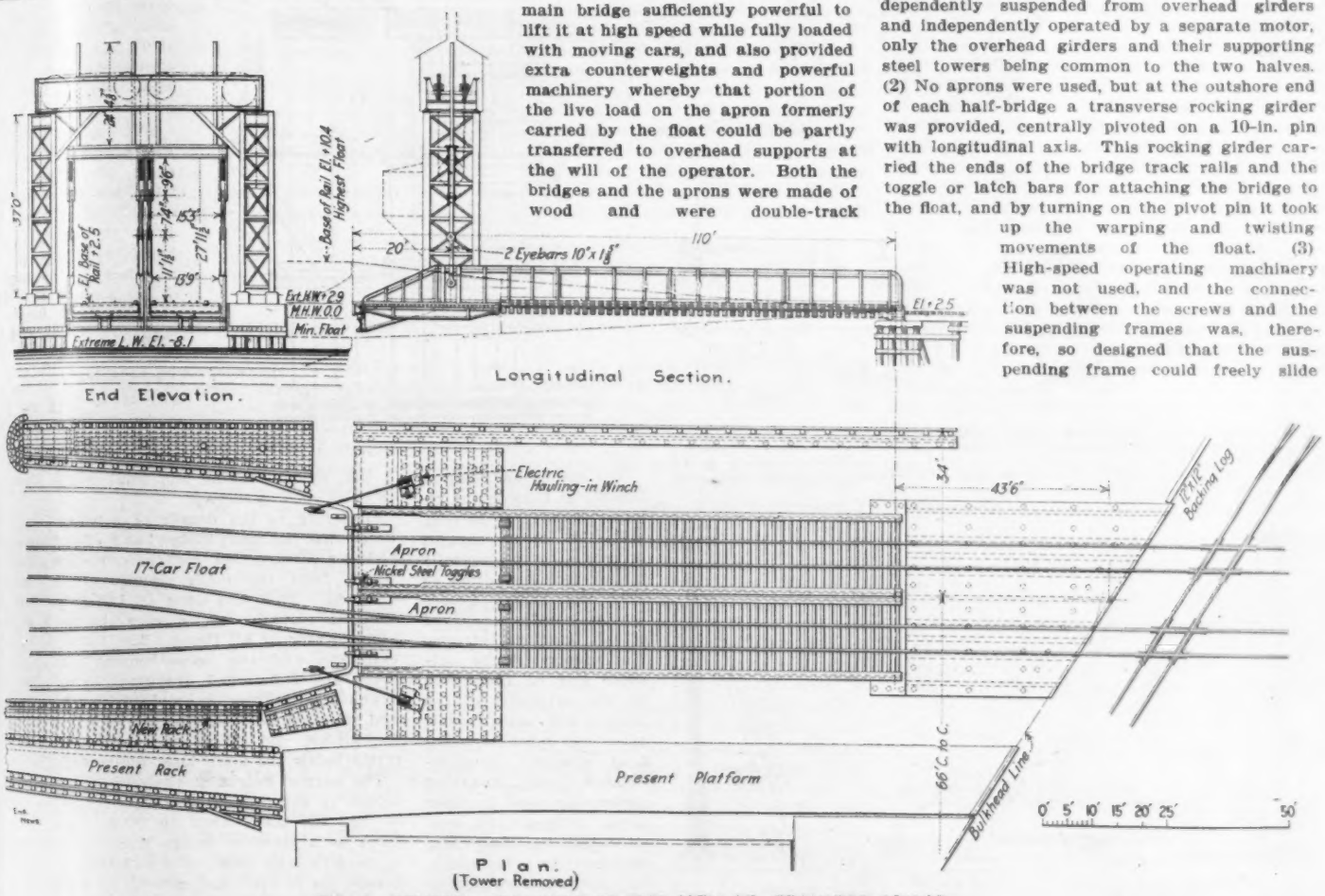


FIG. 4. GENERAL DRAWINGS OF THE 69TH ST. TRANSFER BRIDGE.

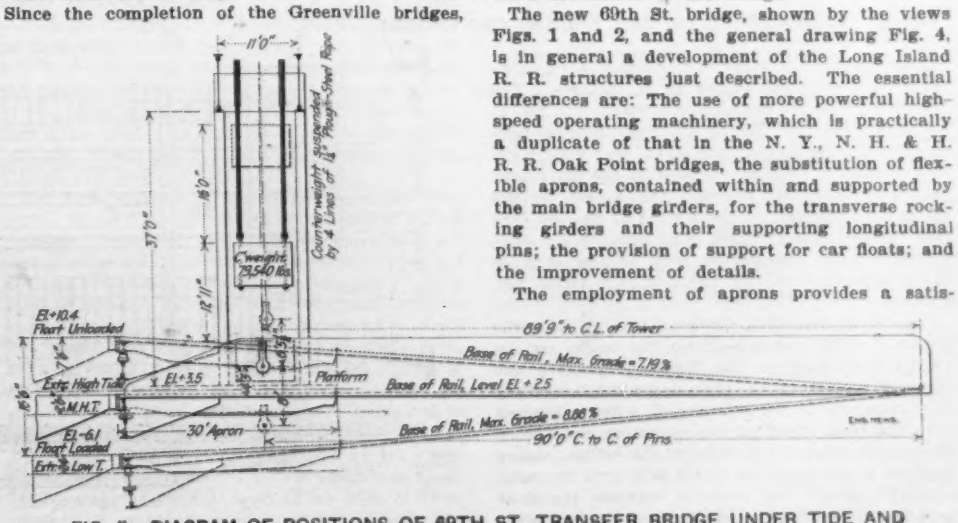
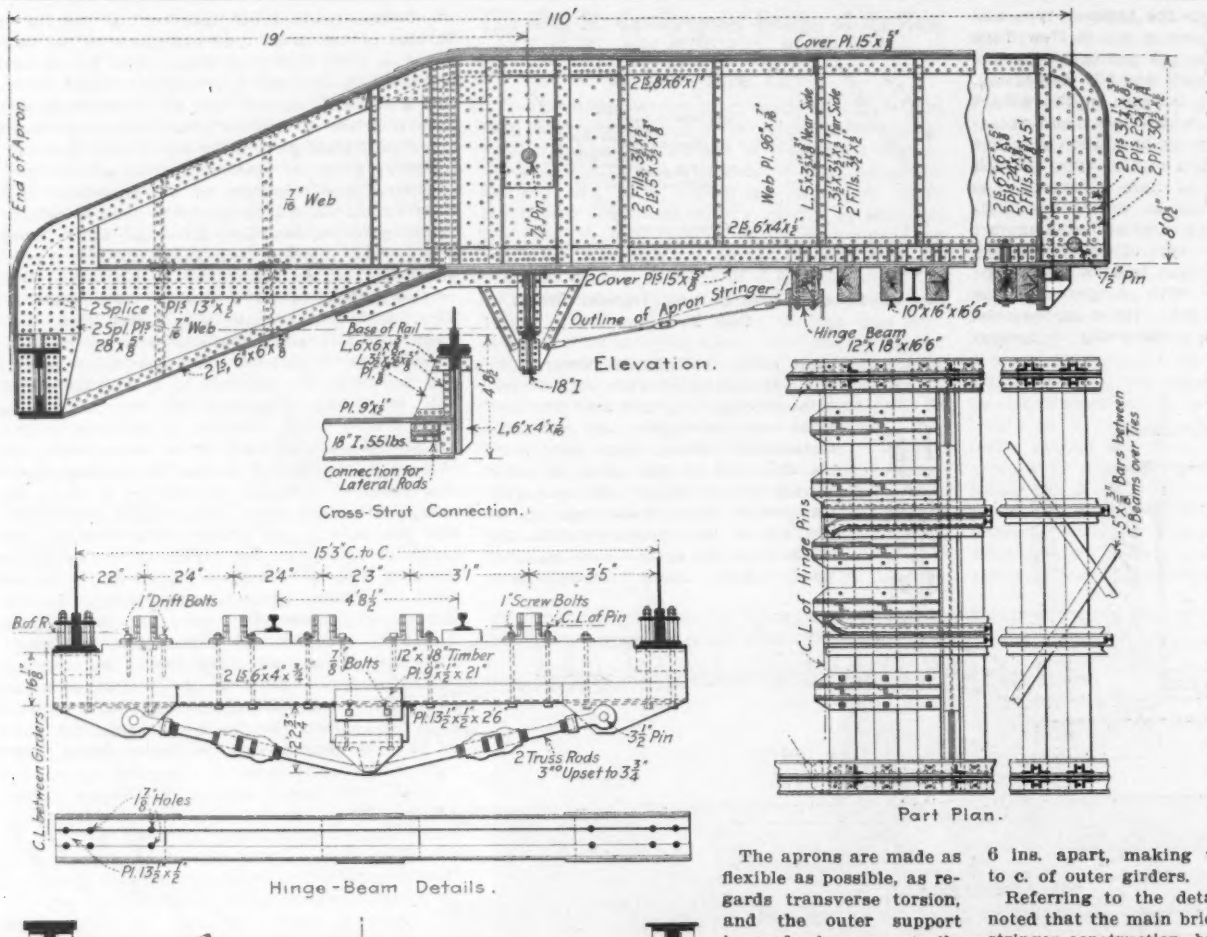


FIG. 5. DIAGRAM OF POSITIONS OF 69TH ST. TRANSFER BRIDGE UNDER TIDE AND LOAD CHANGES.


110'
19'
End of Apron
7/16" Web
Cover Pl. 15"x 5/8"
2 Splice Pls 13"x 1/2"
2 Spl Pls 7/16" Web 28"x 5/8"
2 L 6"x6"x 5/8"
2 Cover Pls 15"x 5/8"
Outline of Apron Stringer
Base of Rail
L 6"x6"x 5/8"
Pl. 9"x 1/2"
18" I, 55 lbs.
L 6"x4"x 7/16"
Connection for Lateral Rods
4'6"
18" I
Elevation.
Hinge Beam 12"x 18"x 16'6"
10"x 16"x 16'6"
7 1/2" Pin
8'0 1/2"
Cross-Strut Connection.
15'3" C. to C.
22" 2'4" 2'4" 2'3" 3'1" 3'5"
4'8 1/2"
1" Drift Bolts
1" Screw Bolts
C.L. of Pin
B of R.
7/8" Bolts
12"x 18" Timber
Pl. 9"x 1/2"x 21"
2 L 6"x4"x 3/4"
Pl. 13 1/2"x 1/2"x 26"
3 1/2" Pin
2 Truss Rods 3" Upset to 3 3/4"
C.L. between Girders
1 7/8" Holes
Pl. 13 1/2"x 1/2"
Hinge-Beam Details.
C.L. of Hinge Pins
5"x 3/8" Bars between I-Beams over Ties
Part Plan.
2 L 6"x6"x 7/8"
2 Pls 24"x 5/8"
2 Pls 30"x 5/8"
2 Pls 31 1/4"x 5/8"
2 Pls 25"x 5/8"
2 Pls 6"x 5/8"
Web Pl. 96"x 3/8"
2 L 5"x3 1/2"x 7/16" Near Side
2 L 3"x3"x 7/16" Far Side
2 Fills. 3/4"x 1/2"
2 Fills. 3/4"x 5/8"
2 Fills. 6"x 5/8"
2 Pls 24"x 5/8"
2 Pls 6"x 5/8"
2 Pls 3"x 3"x 3/8"
2 Pls 3"x 3"x 7/16"
2 L 6"x4"x 5/8"
2 L 5"x3 1/2"x 5/8"
2 L 3"x3"x 5/8"
2 L 3"x3"x 7/16"
2 Fills. 3/4"x 5/8"
2 Fills. 3/4"x 7/16"
2 L 5"x3 1/2"x 7/16" Near Side
2 L 3"x3"x 7/16" Far Side
2 Fills. 3/4"x 5/8"
2 Fills. 3/4

the length of the bridge, and could be reduced by making the bridge longer. The adopted length of 110 ft. was thought to be the maximum desirable at this location without increasing the weight of the structure unduly. A total vertical movement or range of the forward end of the bridge in amount 16 ft. is provided for.

The 96-in. main girders of the bridge and their lateral strutting and bracing are shown sufficiently in Fig. 6. The 18-in. I-beam strut under the suspension yokes is bracketed to furnish the rigidity desirable at this point. This strut is attached to downward extensions of the girder web at such a level as to clear the apron stringers in the lowest position of the apron. The 5 × ⅜-in. flat-bar laterals of the bridge are continued to this strut by diagonals of turnbuckle rods; the 19-ft. extension forward of the strut has no lateral bracing, but its front end is stiffened by the rigid attachment of the support girder which serves as a rest for the front of the apron.

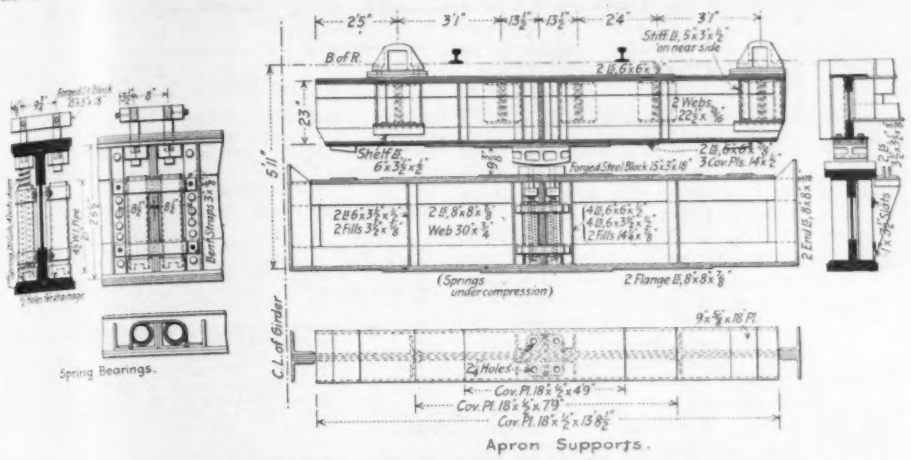


FIG. 8. APRON SUPPORTS AND SPRING BEARINGS.

The suspension yokes, one for each half-bridge (Fig. 10), are attached to the girders by 7½-in. pins seated in bronze-bushed bearings; eyebars are used for the lower portion of the yokes.

The forward end of the bridge is supported by transverse overhead girders resting on steel towers at the sides of the bridge, which are in turn supported by pile foundations capped with concrete from a point slightly above the low water line. The concrete caps are a new feature in their application to pile supports for transfer bridges in this harbor; they were introduced in order to provide permanence in the supports, especially considering the danger of the destruction of timber supports by fire. Aside from fire considerations, the desirability for supports as permanent as the superstructure is readily seen when the difficulty of temporarily supporting the extremely heavy loads during a reconstruction of semi-permanent supports is considered. Creosoted timber was used below the concrete above the mean low water line and for boxing the sides to prevent access of the sea water during the setting of the concrete and to protect the concrete from wave action after hardening. The piles under the forward supports sustain a calculated load of 10 tons each. It was not considered necessary to provide equally permanent supports at the heel of the bridge as the load supported at that end is trivial compared with that at the forward end.

The pile structures in front of the bridge for guiding and protecting boats, known as rack and pin, are of the usual construction with slight modifications in detail.

The heel of each girder is supported on a riveted steel shoe 40 ins. high, resting on a timber substructure. The shoes for the outer girders are two-web assemblages, with webs separated 13¾ ins. to admit the girder flanges. A 7½-in. pin through a reinforced portion of the web-plate provides the connection; this pin is seated 32 ins. above the base of the shoe. The middle shoe is double, taking both the center girders.

The substructure of the heel support comprises a cluster of 16 piles under each outer shoe, and 20 piles under the middle shoe, all 30 ins. on centers, capped with three layers of 12 × 12-in. timbers to seat the shoe. These clusters are strutted back to the pile bents of the approach or spring platform. The spring platform, 37 ft. wide by 43½ ft. long on the center line, with rear edge skewed 122° 20′, rests on four bents 8 to 10 ft. apart. Its deck consists of three 12 × 16-in. yellow pine stringers for each track and 8 × 16-in. center and outside stringers.

To take the buffing shocks, the heel shoes have vertical back face resting against a built-up timber block about 40 ins. square, seated on the rear of the shoe platform.

The apron hinge is not attached to the steel frame of the bridge but rests on a trussed 12 × 18-in. wooden beam which is placed as the forward cross-tie of the bridge. This "hinge-beam" is blocked up solid with the two ties next back, by 10 × 16-in. inserts which give 52 ins. solid timber at the front edge of the floor to transmit buffing shocks from apron to bridge. The five hinge sockets of each half-bridge rest on these timbers; they consist of pairs of 8 × 6 × ¾-in. angles reinforced with plates on the vertical legs, 5 ft. long, overhanging 6 ins. beyond the front of the hinge-beam. The center of pin-hole is 1½ ins. forward of the face of the hinge-beam.

The apron stringers, 28½-in. plate-girders, are pinned to the hinge sockets by 3-in. pins through hinge ears formed of plates extending up from the stringer web. The apron framing (Fig. 7) comprises no rigid cross-connection except the transverse bearing and buffer girder at the front end; at intermediate points the stringers are tied together by flat bars riveted across their top flanges, which of course will not oppose any twisting tendency of the apron.

The bearing girder at the front of the apron is shown in Fig. 7. Its forward face is protected by a timber faced with three 5 × ¾-in. steel plates where the end of the float rests against the apron. The vertical support of the girder is furnished by a central bearing, as detailed in Fig. 7, which rests on a step supported by four coil springs in pockets in the transverse girder at the front of the bridge extension. Side bearings are provided to limit the twist of the apron, but they come into action only in extreme conditions.

The floor timbers of the main bridge are protected by a layer of waterproofing fabric placed over the cross-ties. On this waterproofing are laid the 6 × 12-in. yellow pine rail-stringers (laid flat), and between and outside these are 4 × 4-in. spiking pieces. The object of the rail stringers is to protect the floor timbers, especially to avoid the damage to these timbers due to spiking the rails to them in the usual manner. Longitudinal 2-in. planking is nailed over the spiking pieces. The apron timbers are not protected in this way.

The track has a ½-in. open joint at the apron hinge, but continuous rails over the main hinge. Inside guard rails are used either side of these joints and at the front end of the apron. The forward rail-lengths of the apron are spiked only at their rear joint, about 13 ft. back of the end, and each track has an adjusting screw of the type commonly used, for shifting it laterally a small distance to aline accurately with the track on the car-float. These screws lie horizontally on the deck and have ratchet handles which normally also lie flat on the deck. The rails where not spiked are held to gage by tie-bars.

The left-hand track of the apron contains a switch, 23 ft. 9 ins. back of the end, providing a turnout to reach the middle track of three-track car-floats. The separation of main track and turnout at the front face of the apron is 18 ins.

The four latch bars, or toggles, which connect the car-float to the apron, are located as shown in Fig. 8. Their lateral spacing is 10 ft. 9 ins., 3 ft. 8 ins., 10 ft. 9 ins. Fig. 9 shows their construction. The toggles are 7 × 7 ins. and 5 × 7 ins. in section and 7 ft. long, and are made of nickel-steel. The hand-lever holes in their ¾-in. bed plates were half filled with babbit after placing, to protect the timber below against destruction by the lever points.

The hoist mechanism comprises four lifting screws pinned to the yokes which engage the bridge girders, wormwheel-driven nuts on these screws, self-alining bearings for the nuts as shown in Fig. 11, and motors and gearing. The machinery is supported on an overhead platform carried on towers outside of the bridge with independent pile foundation, as already noted. A machinery house covers the platform. Indicators in the operator's house operated by cords from the bridge and the end of the apron inform the operator at all times of the position of the bridge and the position of the outshore end of the apron with respect to the supporting girder.

The bridge is protected against damage in operating by safety devices consisting of a limit switch and circuit breakers. A limit switch is connected to the horizontal drive shaft, in the machinery house, by sprocket wheels and chain. When the bridge reaches either its high or low range the limit switch opens a circuit which throws the main circuit breakers located on the switchboard in the operator's cabin.

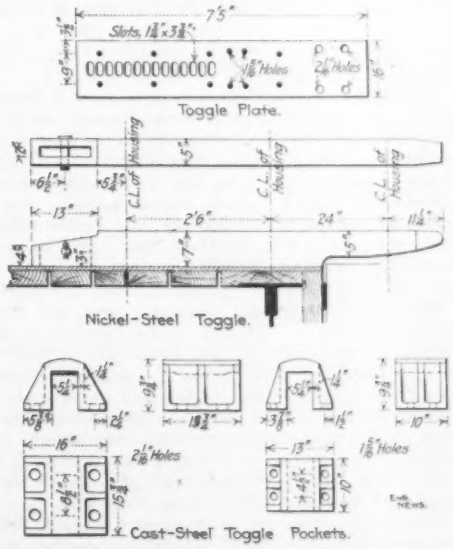


Fig. 9. Toggles With Toggle Pockets and Plates.

Attached to each hoisting screw there is another electrical device with an arm projecting out over the shoulder of the revolving nut, which acts as a limit switch. In the event of the hoisting nut being lifted from its seat by an ice jam or other conditions producing a sufficient uplift, the projecting arm is raised, opening the circuit, which throws the main circuit breakers as before.

Counterweights running in the platform towers balance about 90% of the dead-load on the hoist yokes. Each of the two counterweights is about 45 tons.

The screws are 5½ ins. in diameter at root of thread. They have double thread, of 3¼-in.

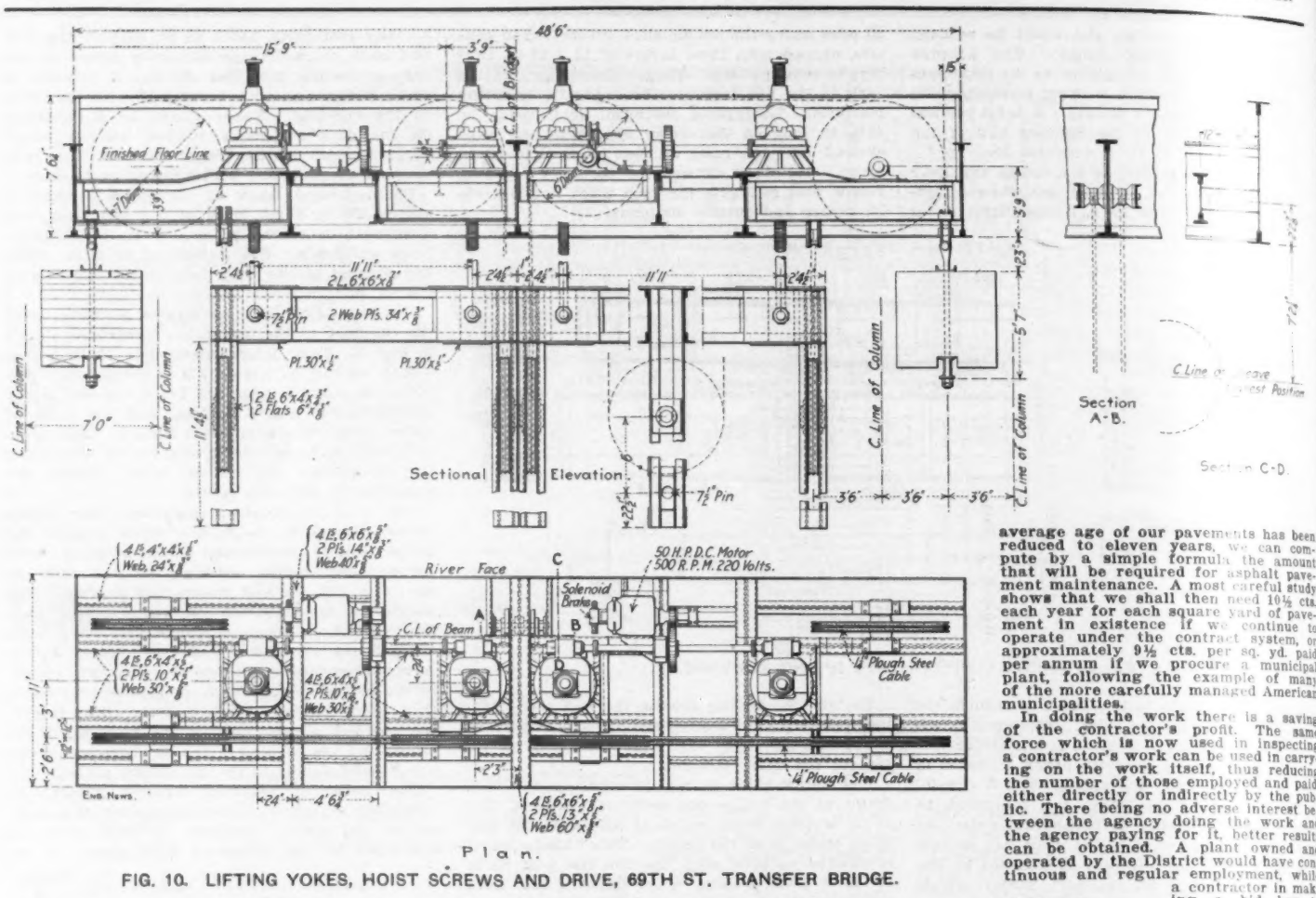


FIG. 10. LIFTING YOKES, HOIST SCREWS AND DRIVE, 69TH ST. TRANSFER BRIDGE.

pitch, giving 1⅝-in. thread spacing. The form of thread is unsymmetrical, as shown in Fig. 11.

The load and stress computations show a dead-load reaction on the hoist bars of about 100,300 lbs. (for each girder), and a maximum live-load reaction of 291,800 lbs. The latter is obtained when the apron bears on the front support and the bridge is fully loaded, and in addition supports a reaction of 112,500 lbs. per girder from the car-float. The greatest load per screw, therefore, is about 300,000 lbs., but the screws are not intended to be operated under this load.

The maximum girder moments are: At the hoist attachment 3,241,000 ft.-lbs. negative; at center of span between heel and hoist, 3,965,000 ft.-lbs. positive. The former is attained when the apron bears on the bridge and carries part of the weight of the float as mentioned above. The latter moment occurs when the apron is lifted off its bearing and the bridge carries full load. The maximum heel reactions are 56,700 lbs. dead-load and 139,800 lbs. live-load.

The unit-stresses for main stresses were 12,000 lbs. tension and 12,000 — 50 l/r compression, to be used with dead-load and live-load without impact addition. The sections of members exposed to frequent wetting were increased, however, to allow for corrosion losses.

The bridge was built by contract with the following: For substructure, Butler Bros. Construction Co., of New York City; for structural work, Phoenix Bridge Co., of Phoenixville, Pa.; and for machinery, Steele & Condict, of Jersey City, N. J. The field construction of the bridge was in charge of Mr. R. E. Dougherty, District Engineer, N. Y. C. & H. R. R. R.

Agitation for a New Building Law in Louisville, Ky., is being carried on by the Architects' Club and the local chapter of the American Institute of Architects. An ordinance has been drafted by Mason Maury, architect. Full fireproof construction within the city limits is one of the objects, and repairing of non-fireproof buildings after material damage by fire is to be discouraged. Greater uniformity of the building line in the residence districts is also aimed at.

Arguments for a Municipal Asphalt Plant for the District of Columbia are stated as follows in the report of the District Commissioners (Cuno H. Rudolph, John A. Johnston and Major Wm. V. Judson) for the year ending June 30, 1911, just submitted to Congress early in December. The Commissioners state:

The Commissioners have included in their estimates for the fiscal year 1913 an item asking for authority to establish and operate a municipal asphalt plant.

In the District of Columbia there are over 3,000,000 sq. yds., or 145 miles, of asphalt pavement. The average life of an asphalt pavement is from 20 to 22 years, and some of the older pavements have been laid 39 years. Two years ago the average age (which is to be distinguished, of course, from the average life) of our asphalt pavements was about 14 years, and this average age was considerably increasing.

Now it is actually cheaper to maintain pavements at an average age of eleven years, resurfacing when the cost of patching becomes excessive, than it is to maintain them on a lower standard and of greater average age. In order to bring the average age down to eleven years, Congress has lately increased the appropriation, and in another year or two we shall have arrived at the point where the pavements can be maintained with the maximum of economy. For 1913 we ask for $390,000, in lieu of the appropriation of $425,000 for the current year. Very soon, when the average age of our pavements has been reduced to eleven years, we can compute by a simple formula the amount that will be required for asphalt pavement maintenance. A most careful study shows that we shall then need 10½ cts. each year for each square yard of pavement in existence if we continue to operate under the contract system, or approximately 9½ cts. per sq. yd. paid per annum if we procure a municipal plant, following the example of many of the more carefully managed American municipalities.

In doing the work there is a saving of the contractor's profit. The same force which is now used in inspecting a contractor's work can be used in carrying on the work itself, thus reducing the number of those employed and paid, either directly or indirectly by the public. There being no adverse interest between the agency doing the work and the agency paying for it, better results can be obtained. A plant owned and operated by the District would have continuous and regular employment, while a contractor in making a bid has to cover not only the period when his plant is working on the contract for a limited time, but also the period when the plant is idle. These considerations indicate the economies that would result from the ownership of a plant by the District. Municipal asphalt plants are now in operation in Detroit, Columbus, Dayton, Indianapolis, Kansas City, Denver, Seattle and elsewhere.

A site is available along the water front, and this site also has railroad facilities.

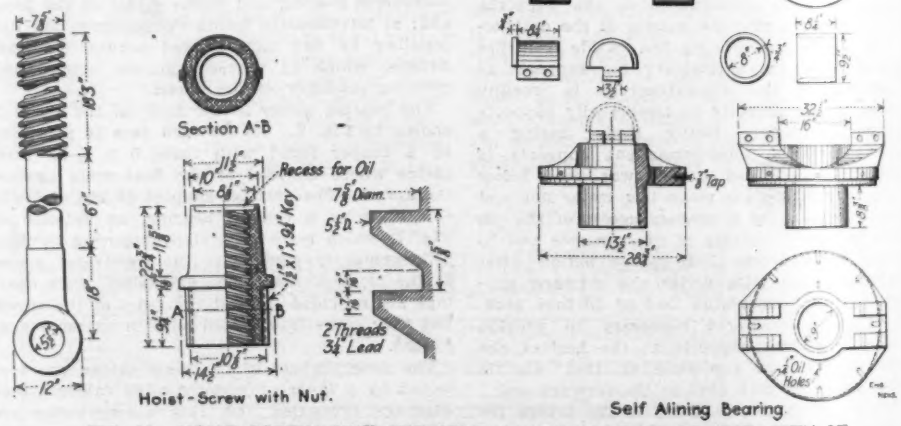


FIG. 11. HOIST SCREW, NUT AND SELF-ALINING BEARING OF NUT, 69TH ST. TRANSFER BRIDGE.

Telephone Rates of the Manitoba provincial-government system are reported recently to have been practically doubled. It will be recalled that the provincial government recently took over the plant of the Bell company in Manitoba a few years ago and cut the prevailing rates in two. It is now stated that the present rates do not yield sufficient income.

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ADVERTISING

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Entered at the New York Post-Office as Second-Class Matter.

Drastic "Recall" Provisions for a Board of Engineers.

An unusual and in certain respects remarkable procedure for appointing an engineering board is specified in an ordinance pending before the Pittsburgh city council in the matter of a franchise for a subway system. The board is to contain a city representative, a company representative and a joint representative; this is not in itself remarkable, but the tenure of office of the members is not certain or fixed, and there seems to be a considerable conflict or doubt as to the method of removal and appointment. The pertinent sections of the ordinance are as follows:

Section 3.—Within one month after the acceptance of the ordinance by this company a Board of Supervising Engineers shall be appointed for the purposes hereinafter set forth, consisting of three members to be appointed respectively as follows: One member to be appointed by the Mayor and Council of the City, and to receive from the City a salary to be fixed by ordinance; the second member to be appointed by the Company, and to receive from the Company a like salary; and the third member to be appointed by the Mayor and Council and the Company, jointly, and to receive a like salary, half from the City and half from the Company.

The said Mayor and Council, or the Company, may respectively at any time, and from time to time, remove its representative on said Board and appoint another. No removal or reappointment shall take effect until written notice thereof has been given the other party, by the party making such removal or appointment.

The said Mayor and Council, and the Company, or either of them, may at any time, and from time to time, remove the third member from said Board. In case of removal by one party to this ordinance, written notice thereof, together with the reason therefor, shall be given to the other party at least thirty days before said removal shall become effective.

If the Mayor and the Company be unable, either in the first instance or in case of vacancy, to agree upon appointment of the third member within thirty days, such third place shall be filled by appointment made by the judges of the Court of Common Pleas No. 1 of Allegheny County or a majority thereof. The third member of the Board shall be ex-officio chairman of the Board. A majority of said Board shall at all times be authorized to exercise the powers conferred by this ordinance on said Board.

It is proper to remark, in comment on these provisions, that, just as in the case of any governing or working body, a certain amount of stability is essential to the successful working of an engineering board or commission. The procedure specified in the above-quoted section of the Pittsburgh ordinance does not provide this desirable stability; certainly not in a critical situation, which is the time when the method of constituting the board is put to its real test. No reason is apparent, and no condition known to us furnishes a reason, for the unusual scheme of removal by any one of the several bodies, and appointment also by any one of several bodies, as specified.

On the contrary, every consideration of proper conduct of a large constructional undertaking speaks for maintaining such a supervisory board as nearly unchanged and as nearly of the same mind as possible, over a long space of time. Efficient service on commissions of the character of the Pittsburgh subway board is to no small extent dependent on the acquisition of detailed knowledge of the work; for, even the best ability and judgment can be applied to the subject with good effect only after such knowledge has been acquired and the mind has had time to analyze the problems in hand.

It is clear that the procedure contemplated in this ordinance would militate against successful administration, and would create rather than solve difficulties. We interpret the above-cited clauses as an endeavor to accommodate, not to say conciliate, the intending subway franchise bidders whose offers were pending at the time this ordinance was under consideration. In this light, however, it is ill-advised, for the work of the company would be under no disadvantge without the extensive power over the board which the company is given, whereas with this power the temptation would be great on frequent occasions to exercise the veto power specifically conferred.

Quite aside from these considerations, however, the very nature and purposes of the proposed Pittsburgh subway board do not require any direct representation of the company on the board. The board is appointed only to serve the city and conserve its interests. The company is already represented when it makes the plans, a work in which the city has no share. The city's turn comes thereafter, and the board is the city's representative at that stage.

An Old-Time New Year's Greeting to Engineers.

We reproduce the above cut, by request of a valued old-time contributor, from our issue of Jan. 7, 1888; and in doing so we realize that the changes in our subscribers during that period have been so great that the sketch will be new to more than nine-tenths of our readers. For one thing the number of subscribers to Engineering News at the present time, is fully five times what it was in 1888. Those were indeed the days of small things in the engineering profession and of modest beginnings with Engineering News.

It will interest many of our older readers to know that the artist who made the sketch was Mr. D. McN. Stauffer, whose name is inseparably connected both with the early days of Engineering News and with its years of rapid development.

The sketch originally appeared without description or comment, and it needs little now. It may be well to say that there is no suggestion intended that 1912 is likely to prove a cold year for engineers; on the contrary, we sincerely hope that as certainly as the change of seasons will thaw the icicles off the chilly surveyor, so a period of prosperity will succeed such financially inclement weather as too many engineers have had to endure in 1911.

Those of our readers who have bound volumes of Engineering News extending back to 1888 will find, if they turn to the first number of that year not only the sketch herewith reproduced, but among the editorials of that issue a characteristic sermon by the late A. M. Wellington, entitled "Turning over a New Leaf." We reprint a paragraph from that sermon, for the advice it contains is as excellent now as it was twenty odd years ago.

No amount of study or fidelity can entirely neutralize the effect of the great and enduring differences in the natural capabilities of men, so that the fortunes of men can never be alike very closely, let them do what they will. But as a high grade of faithfulness and of industry are in even greater demand than a high grade of ability, of which indeed they are the larger factors, and as these gifts are within the reach of every man who chooses to have them, they alone will assure him of a degree of success of every kind which should suffice for reasonable ambition, and make each successive year a happy one.

A similar note to that in Mr. Wellington's editorial is sounded in the following verses* received recently, and printed below as appropriate matter for our end-of-the-year number.

A mule there was, and it worked in the ruck
Under a wide highway,
In a subway cut, where it pulled a truck
Piled high with gravel and rock, and muck,
And sometimes a girder or two for luck,
And all it was fed was hay.

The mule was lean and lank, and thin,
And a bad light filled its eye.
The joints of its bones showed through its skin
And the devil himself seemed to dwell within,
For it took a kick at the driver's shin
Whenever it passed him by.

For every kick it received a blow
With shovel, or plank, or brick;
For in spite of its meanness it had to go,
And the gait it went was far from slow,
And its life was one of direst woe;
Tortured, and sore, and sick.

And every day, as it pulled its load,
Down where the light was dim,
Hurried along by the driver's goad
Over the bumps and ruts in the road,
A worse disposition the mean brute showed,
As it kicked and bucked with vim.

At last, while going its narrow route,
It bucked and jumped aside;
The mule and the truck went down a chute;
A broken plank made a hole in the brute;
A policeman was called with instructions to shoot,
And nobody mourned that it died.

The mule that was hitched to the truck next morn'
Was gentle, and pulled with a will.
Its mane and tail were kept neatly shorn;
The bedding it had was free from thorn;
And along with its hay it was given corn,
And ate till it had its fill.

This mule waxed sleek and fat, and trim,
Down in the subway cut;
The blow of a lash was unknown to him,
For he pulled and tugged with a willing vim,
And the load was eased by the driver grim,
Whenever it stuck in a rut.

Now the moral that this little tale would teach
Is true, and as old as the hills!
To the heights we desire, we all may reach,
And a helping hand is held out to each—
Though it isn't the writer's intention to preach—
Our acts are the cause of our ills.

But in printing this, as well as the quotation from Mr. Wellington's editorial, we are minded

*By Eugene G. Haines, 254 Jefferson Av., Richmond Hill, N. Y.

to couple with them words of encouragement. One cannot fairly judge the progress of engineering or the position of engineers by observing at a single season, or looking at isolated cases. When one takes a long distance view in true perspective, it is evident that engineers and engineering work are becoming more and more necessary to the world in a hundred different vocations which knew nothing of engineering half a century ago. The public cannot do without the engineer, and his services must eventually be better appreciated and better rewarded.

If we have played some part in aiding engineers better to fulfill their responsibilities to each other and to the public, it is one of the greatest satisfactions that has come with the years which have passed since the view on the previous page was first published.

A Six-Year Course in "Conservation Engineering" at the University of Michigan.

We have frequently alluded in these columns to the unfortunate tendency toward specialization in the engineering schools and the establishment of courses on various subjects merely because of some popular agitation. It is through yielding to popular clamor in this way that our engineering schools frequently subject themselves to just criticism.

We have before us a copy of the "Michigan Technic" describing the six-year course in "Conservation Engineering" established two years ago in the University of Michigan. The following paragraph, describing the degrees conferred upon the students who successfully pursue this course, is worth reprinting.

> The degrees to be conferred for this course are as follows:
>
> On the completion of 140 hours of work, requiring four years and a summer session, the degree of Bachelor of Science in Engineering; on the completion of 175 hours of work, requiring five years and a summer session, the degree of Master of Science in Engineering; on the completion of 210 hours of work as above, requiring six years and a summer session, the degree of Master of Conservation Engineering (M.Cn.E.).

Any engineer reading the above must wish that the engineering schools could see their way clear to abolish entirely the absurd degrees which they have copied from the old-time college customs. It is not worth while to criticise the time honored college custom of granting the degree of "Master of Arts" to a student who has completed a four years' course and done certain post-graduate work, because everybody knows that the recipient of such a degree is far from being actually a Master of Arts, and is very often master of nothing save a few scholastic acquirements.

But when the engineering schools adopt this fetish of the old-time college and apply it to their students, the degrees become so absurd that no graduate with common sense cares to use them. Who is there who could claim to be really a "Master of Science in Engineering?" Certainly no graduate who has merely completed five years of work in a school and has had no experience as yet in practical work of the profession, could pretend to such distinction. And yet the giving of such a degree is reasonable compared with giving the title of "Master of Conservation Engineering" to a man who has merely completed six years of study in an engineering school. Every engineer, to the degree in which he is competent in his special field of work, is a conservation engineer. The mining engineer practices conservation when he plans the best method of developing a mineral deposit so as to secure the greatest amount of valuable material with the least outlay. The mechanical engineer practices conservation when he designs machinery so as to produce a given output with the least consumption of raw material and of labor. The civil engineer practices conservation when he locates a railway so that a dollar invested in it will earn the greatest amount of interest.

There is as little need for "conservation engineers" as a distinct branch of the profession as there is for a separate set of "efficiency engineers." Every engineer who is really competent will follow the principles of conservation and will seek efficiency in all his work. The idea, therefore, that any student by any course of study can become expert in all lines of conservation engineering, is absurb on its face.

Mr. R. T. Crane, of Chicago, has criticised the technical schools on the ground that they hold out false hopes to the students who take their courses. His criticism is absolutely justified in such a case as that before us. The students who take this six-year course in conservation engineering may indeed secure some valuable ground work in engineering studies; but if they go out at graduation and write "Master of Conservation Engineering" or hieroglyphics that stand for it after their names, they will make themselves ridiculous in the eyes of intelligent men. If the University encourages them to take the six-year course in the expectation that they will find lucrative positions as "conservative engineers" on graduation, it is deceiving them and doing them a serious injury.

We may repeat here what has been often said in these columns and what we believe is the opinion of the ablest men in the engineering profession and among engineering educators: that specialization in engineering education is, in almost all cases, a mistake. The time to specialize is after a man has completed his engineering studies. In nine cases out of ten, circumstances determine what branch of engineering a young man takes up after graduation; and he often follows some branch entirely different from that in which he specialized while at college.

Federal Aid for Highway Improvements.

The American Association for Highway Improvements in its recent convention at Richmond adopted a resolution favoring Federal appropriations for highway work with only two dissenting votes in a convention of 800 delegates. The American Automobile Association at a convention to be held in Washington, on Jan. 11 to 14, is to have as its main subject means for securing Federal appropriations for highway work.

It is easy to roll up a great volume of enthusiasm in favor of such a movement. The eminent statesman who was always in favor of "the old flag and an appropriation" is representative of a large class. Moreover, there are enormous and powerful business interests who are ready to back such a raid on the National Treasury because it means profit to themselves.

But when it comes to the presentation of serious reasons why the Federal Government should, for the public benefit, undertake the building of highways, we have yet to hear a single one which will bear analysis.

The common argument for Federal aid is substantially that good roads are a benefit to the locality in which they are built worth many times their cost and that the Federal Government cannot bestow greater public benefit than by spending the money in its treasury on construction of good roads.

People somehow fail to realize that the treasury of the nation, like the treasuries of states and cities, has no other source of income than the taxes paid by the people. The taxpayers must pay the cost of building and maintaining roads, whether built by the nation or by states or counties or towns. What advantage is there to the taxpayer in paying his money for road work over to the United States? Will the money be appropriated more wisely or expended more intelligently or economically? Any one who holds such an idea has small knowledge of the way appropriations are made in Congress or of the contrasts of lavishness and of cheese-paring niggardliness with which a large part of our Federal business is conducted.

There are, indeed, sound arguments in favor of *state* control of state highways, and state supervision of highway work generally. But even here the state expenditure is usually devoted to the main highways whose condition is important to a much larger area than the community in which they lie. The cities are left to pave their own streets and the country towns to provide such local roads as their taxpayers can afford to build and to maintain. This is in accord with sound principles of government. If good roads really produce the enormous benefits to the localities in which they are built that the good roads advocates claim, then by all means the localities which receive the benefit should bear the burden of paying for it.

And good roads construction by local bodies is in fact making magnificent progress. By way of illustration, we have before us a report of the Tennessee Geological Survey showing that during the year 1911 the funds raised for road construction by the various counties of Tennessee aggregate not less than six and one-half million dollars.

This is only a sample of what is being done by towns, cities, counties and states all over the country. What need is there, therefore, of Federal Government interference? Is there any real "interstate commerce" which calls for Federal appropriations? The demand of the automobile manufacturers for through highways for the use of tourists will certainly be supplied without raiding the National Treasury.

It needs but the slightest knowledge of Congressional methods and precedents to perceive that the first grant of Federal aid to highway work will be the opening of a drain out of the Treasury which may easily menace national solvency.

Whatever statesmanlike ability a Congressman may possess, custom and precedent compel him to work for appropriations to be spent in his own locality, regardless of their merit. Millions upon millions of taxpayers' money are poured out annually, not for the national benefit but to have money spent in this or that or the other Congressional district. We have far too many navy yards, and they are kept up not for economical and effective national defence but because to abandon some of them would lower the price of real estate and cut down the market for groceries in certain cities. Our army is scattered in little detachments all over the country, because no Congressman will consent to have the "fort" in his district abandoned. If it were given up, how could he get back to Congress? Our River and Harbor appropriations have for a generation been distributed, not with a view to concentration of funds where navigation would be most benefited, but where log-rolling bargains compelled. Even as we write, efforts of Congressional leaders to economize in public expenditures are being frustrated by the insistence of members that a big pork barrel for constructing public buildings must be opened at this session.

And if a new outlet is opened by which Congress can vote away public money to be spent in this or that or the other locality on good roads construction, there will be another annual scramble at Washington, and another great obstacle will be placed in the way of intelligent and wise legislation there.

Surely there are directions enough in which Federal action and Federal appropriations are urgently needed to absorb all the funds the Treasury can spare. It is to be hoped that Congress will realize this and not be stampeded by the interests which are fostering the agitation for Federal aid to highway construction.

Since the above was put in type, President Taft, speaking at a dinner of the Automobile Club of America in New York City has taken strong ground in opposition to Federal expenditures for highway construction. We quote the following sentences from his speech:

> The question of good roads is a difficult one. Who is to pay for the roads? Are they to be built by the State? Are they to be built by the county? And who is to take care of them? I hear the earnest patriot (and it does not make any difference how he construes the Constitution, if there is any plan of running a National road near his farm) I hear the earnest patriot say: "It is the business of the general government to build these roads. Let's have a National road running from New York to San Francisco, to teach the world what a model road is." "But what would it cost?" "Oh, what difference does it make what it costs? You can scheme and hunt ways of saving a hundred thousand dollars in the matter of employees at Washington

but when it comes to building roads, what is a hundred million between friends?"

I venture to question the wisdom of opening that method of spending Federal Government money. I think it is much better to have the neighborhood and the State as a large unit expend its money in the construction of roads across the State, and aid the counties to keep the roads in repair, because if you once set out upon a plan of National roads, in addition to the plan of National waterways, I do not know how great the expenditure will become.

We have 48 different States, and every State is as anxious to share in the common funds at Washington as every other State. It is a dangerous experiment. I would suggest great delay and deliberation before you undertake so great an expenditure, the ultimate amount of which cannot be foreseen.

Engineering News in a New Dress.

The present number completes the sixty-sixth volume of Engineering News and the thirty-seventh year since the journal was founded. In the sixty-seventh volume, the first number of which will appear next week, radical changes will be made in the size and appearance of the paper.

We can readily understand that to some of our old-time readers, who have been for many years accustomed to Engineering News of the size and general appearance that it has so long had, the change will come as something of a shock. It will be to some of these, we doubt not, as if an old and valued friend who had long worn clothes of regulation cut and style should suddenly appear in an entirely different garb, so that only by close scrutiny could he be recognized. It is proper to say here, therefore, that just as the change of apparel by an old friend, does not change the man himself, so Engineering News is to be the friend, the assistant and the defender of the engineering profession in the future as in the past, no matter what its outward garb may be.

Having said this by way of preface, let us now explain that these changes in the outward appearance of Engineering News are made not as a matter of caprice or mere desire for change, but with the definite object of making the paper more convenient and therefore more useful to its readers.

Not a few of our older subscribers have, at various times, objected, and with reason, to the small size of type in which much of the matter in Engineering News has been printed. The governing reason for the use of small-sized type in our pages has been the desire to compress the largest amount of information possible within available limits of space. As so many of the readers of Engineering News bind their copies and preserve them for reference, it is desirable that the bulk of the paper be kept down as much as is consistent with the presentation of the vast amount of matter which is all the time demanding record.

It has been deemed wise at this time, however, to considerably enlarge the size of type. The new dress of type, which is uniform with that of other journals issued by the Hill Publishing Co., is of a somewhat larger and more legible face than the larger type heretofore used on Engineering News. Further than this, a much smaller proportion of the matter in the pages will hereafter be printed in the small, nonpareil, type heretofore used. Matter still printed in the small type will be generally articles which are not read through seriatim, but are useful for reference only, such as tables and specifications.

The legibility of the paper is also increased by a reduction of about 20 per cent. in the size of the reading matter page. This gives a narrower column and a length of line which the eye more readily follows. Some forty years ago an International congress was held in Switzerland, made up of expert oculists and other eminent scientists, to determine upon the length of line in proportion to size of type which could be followed with the least fatigue to the eye. That congress settled upon the line of 13½ pica ems length as being the longest which could be followed without moving the muscles of the eye-ball. Newspapers throughout the world very generally adopted this narrow column width, after the decision of this congress; but in class journals there has always been a great variation in size and make-up. Within the last few years, however, there has been a strong tendency among technical journals to conform to one standard size. The standardization has come about, partially at least, in response to the action taken years ago by the railway, mechanical and engineering societies in the adoption of standard sizes for publications.

The advantage of the smaller size in enabling a copy of the journal to be more readily carried in a coat-pocket by the busy man who reads his Engineering News while on a railway train, will appeal, we doubt not, to very many of our readers. The smaller size is also a very important advantage in binding the completed volumes of the paper and in the handling of these volumes in the library.

It is of interest to record that the change in size actually restores Engineering News to the size which was adopted when it was founded in 1874 and which was maintained during the first two years of publication.

It will interest our mechanical readers also to know that the development of printing presses in the years since Engineering News was established has contributed to bring about and also make possible the change in size. In printing it will be understood that the number of pages on a form must always be a multiple of two, to provide for successive foldings of the sheet.

Up to some 15 years ago the largest sized printing presses in ordinary use were capable of printing a sheet of paper containing eight pages of Engineering News, of the 8½ × 11½ in. size. Since then presses have been built large enough to print a form containing 16 pages of the 7 × 10 in. size, which is now the standard for most technical journals.

As the cost of printing press work varies directly with the number of impressions necessary, it costs practically no more to print a form of 16 pages than a form of 8 pages, and the larger-sized press printing the smaller page, therefore, nearly cuts in two the cost of press work in the mechanical production of a journal.

Other changes to be made in the appearance and make-up of the paper are mostly of minor importance, and will need no explanation. There is one, however, concerning which a word may be said, because it will appeal, we believe, to very many busy readers. Important articles, worthy of special notice, will be given a title extending across the full width of the page, and in the center beneath the title will be given a few paragraphs summarizing in brief form the gist of the article and the principal conclusions which are reached in it. The busy man in turning over the pages can quickly scan these head-lines, and by glancing at the condensed summary of the article can determine whether he wishes to take the time to read it in full.

In the general arrangement of the paper as few changes as possible have been made. The most noticeable one is the transfer of the department of "Letters to the Editor" to a position preceding instead of following the editorial pages. This is made advisable by the schedule of press work made necessary by the larger number of pages now printed at once.

It is only giving credit where credit is due to say that the typographical excellence which has been maintained in Engineering News during the past dozen years and more is due to the painstaking fidelity and careful work done by the printers of Engineering News during these years, the Record and Guide Press, conducted by Mr. Charles J. O'Brien.

With the beginning of the new volume, however, the composition and press work of Engineering News will be undertaken by the Hill Publishing Co., the present owner of the journal, in its own printing office. The character of the work done by this office on the other Hill journals is sufficient guarantee to our readers that Engineering News in its forthcoming volume will be of satisfactory typographical excellence.

LETTERS TO THE EDITOR.

The Unselfishness of the Engineer.

Sir: Since I graduated with the degree of "B. S." in M. E.-C. E. from my alma mater, I have had 14 years' experience as a field engineer and Superintendent of Construction for contractors and have come in contact with all classes of tradesmen and mechanics as well as brother engineers. I have often noted the jealousy existing between various classes of mechanics, ambitious for promotion, and the tricks resorted to with the object of "downing" a competitor. Occasionally something of the kind is met with among engineers, but I am proud to say that few cases have come under my observation. Our "golden rule" seems to be "Help every one who can and will benefit by your help, and hope for your reward to follow." Yours truly,

J. S. Calhoun, Jr.

131 Ashley Ave., Charleston, S. C., Dec. 17, 1911.

Observations on the Collection and Disposal of Garbage: Correction.

Sir: On page 665 of your issue of November 30, 1911, under the title "Some Observations Upon the Collection and Disposal of Garbage," you give a brief outline of a paper which I sent to the annual meeting of the New Jersey Sanitary Association at Lakewood on Nov. 24, 1911. In the fifth paragraph of this outline, the following appears:

> Altogether, the one-can, or no-separation, system gives most satisfactory results at the house and, as it results in no great increase in the cost of final disposal, little objection can arise on the score of cost.

This conveys quite a different meaning from that which I intended. The following statement, which is quoted from the copy of the paper read by Mr. Hering at the meeting, gives the correct impression:

> Further, this treatment will not greatly affect the cost of the collection system, but, in many cities, is likely to increase the cos of disposal, and this increase may be taken as a measure of the cost of a better service secured by the one-can system.

May I ask you to call this matter to the attention of your readers? Yours very truly,

Samuel A. Greeley.

Winnetka, Ill., Dec. 20, 1911.

Competition of State Highway Departments With Independent Bridge Engineers.

Sir: It may not be entirely out of place in connection with your valuable editorial of Nov. 16, entitled "An Offer of Free Highway Bridge Engineering Work by a Federal Bureau," to cite an instance of recent date which has occurred in our own practice.

We received a report during the year that a certain village and county in this State proposed to erect a steel bridge and recently the respective boards voted to construct the above bridge. A letter from the village board informs us that

> The State Highway Commission have in hand the matter of drawing up plans and specifications for the proposed —— bridge and we believe the matter of superintendence of same will also be taken care of by them.

This is confirmed by a later report that the plans will shortly be completed and bids received at once. That the undertaking is of some magnitude may be judged from the fact that the entire structure is to be about 1,000 ft. long and contains a draw span.

Of course, the policy of the local State Highway Commission does not govern the proposed policy of the Federal Bureau, but merely indicates what is possible.

We feel that our opportunities in connection with work similar to the above are greatly restricted by the competition of the State Highway Commission; and though we appreciate the valuable service they have rendered the State in improving the design and construction of public bridges, we believe their services to the State would be equally effective if they acted in the capacity of a Consulting Board whose duty would be to pass on the plans and specifications submitted by the various competitors for the work, rather than to become one of the competitors.

We believe that such work as the above lies in the province of consulting engineers, and it is an injustice to our profession to have the work taken over by the State, though we would be heartily in favor of the State passing on the relative merits of the various designs submitted.

This instance merely shows to what degree the activities of a Highway Commission may be extended and it does not seem in the least impossible that the work of the Federal Bureau may reach much further into the field of the consulting engineer. Yours very truly,

Federal Engineering Company,
By L. D. Williams.

Stevenson Building, Milwaukee, Wis., Dec. 18, 1911.

The Height of Chimneys as Defined by the Chicago Building Ordinance.

Sir: In Engineering News of Nov. 9, 1911, there appeared a letter from Mr. Ernest McCullough in regard to the required height of chimneys in Chicago, giving his interpretation of the section of the Building Ordinance which relates to that subject. I cannot agree with his view of the meaning of paragraph "C" of section 577, of the ordinance, and would like to present the following as a possible solution of the intended meaning.

Paragraph "C" must be considered as supplementary to paragraphs "A" and "B," which give definite rules for finding the minimum allowable height of any chimney forming a part of a building, except in the case where there is a wooden tank, pent-house or roof-house in the vicinity of the chimney. My understanding of section 577, as quoted in Mr. McCullough's paper, is as follows:

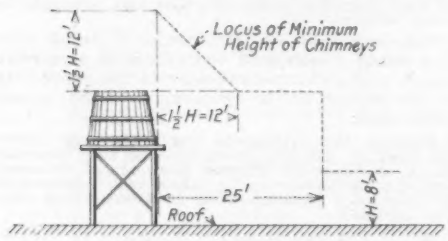


Fig. 1

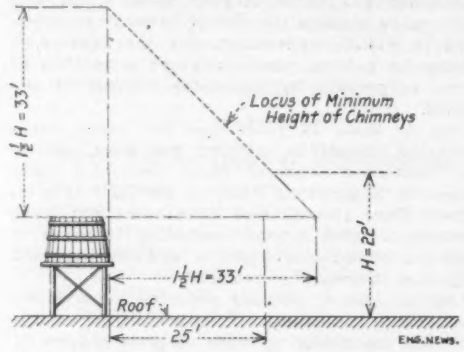


Fig. 2

DIAGRAM ILLUSTRATING F. N. HATCH'S INTERPRETATION OF CHIMNEY-HEIGHT RULE IN THE CHICAGO BUILDING ORDINANCE.

From paragraph "A" the height of a domestic chimney must be at least 5 ft. From paragraph "B" the height of non-domestic chimneys must be not less, in feet, than the greatest diameter in inches divided by four, plus 5 ft. In case, however, the chimney is less than 25 ft. from any tank, etc., the top of the chimney must be no lower than the top of the tank. It must be as much higher than the top of the tank as is necessary to satisfy the condition that, if the distance from the chimney to the tank is less than a certain amount, the sum of the difference in elevation of the top of the tank and chimney, plus the difference between them, must not be less than 1½ times the height of the chimney required to satisfy paragraphs "A" and "B." I append two sketches, Figs. 1 and 2, to show the locus of the lowest allowable height of chimney for each of two typical cases, H being the required height of chimney. The specifications admit of a considerable difference of opinion and give a rather good example of the character of some of our municipal building codes.

F. N. Hatch.

10 Bridge St., New York City, Nov. 29, 1911.

More Concerning Free Engineering Work by Government Bureaus.

Sir: In this morning's issue you have generously printed my long letter of Nov. 30 respecting your criticism of the Office of Public Roads for offering the services of its engineers gratis to towns for bridge engineering, and you have done me the honor to comment upon my letter as a whole.

A reply to yqur comments would be little more (or less) than a repetition of my arguments; for these seem to have escaped your attention. It may, however, be in order to sum up the situation briefly, even at the cost of some repetition.

1. "Free competition" demands that work be done by that agency which (all things considered) can do it best and cheapest. It rejects the notion of maintaining a charity hospital for the coddling of the weaker competitor.

2. Fairness does not require the handicapping of the stronger competitor. Engineering News does not restrict its output of information, or maintain an artificially high subscription rate, for the sake of "fairness" to any weaker rival.

3. In any given case, either a Government bureau or an independent engineer can do the work better than the other, or they can do it equally well and cheaply.

4. In your article of Nov. 16 you admitted that the individual engineer has no chance against the competition of the Roads Office; and you now admit, "If it can be shown that a Federal Government bureau can do the work—better and more economically—'it may properly be argued' (is there room for argument? J. C. T. Jr.) that the work should be so concentrated." In other words (quoted from my former letter) "for the private practitioner to protest (as you advise) against governmental or other competition would be simply to proclaim that he finds himself outclassed, and that he can be saved only by artificial suppression of competition." A Government bureau has the same right to offer its services gratis, for the public good, as Engineering News has (by its superior facilities) "to give us, for a dime, what no struggling privateer could give us at any price."

5. But you now also say: "When brains are the chief element in success, it has been amply demonstrated that the independent worker can beat the huge combination (such as Engineering News?—J. C. T. Jr.) in the race of competition." If this (instead of your opposite statement) is true, then the independent engineer gets the job. He needs no defence and has nothing to protest against.

6. In either case, he should resent, as an impertinence, your proffered championship.

The development of Engineering News is a splendid illustration of the process by which competition inevitably leads to monopoly, the process by which we are irresistibly advancing from individualism (savagery) to socialism (civilization). The vast increase in our well-being, which has already resulted from the incomplete process, is but a foretaste of the wealth in store for us all when the evolution shall have been consummated.

In the meantime, this process (like all advance) works hardship for those who cannot or will not adjust themselves to the new order. The railroad put out of business many a stage-coach driver, "struggling to make a living by independent practice," and doubtless the patriotic journals of that day encouraged the drivers to protest against the "unfair" competition; but the wise drivers were not those who went about bleating their vain protests, but those who "found out which way the procession was going,—and then got in front."

All this, of course, refers to "free competition" in general, and not specially to any particular bureau, or to the question whether it has been "guilty" of serving its master (the public) as well and as economically as it can and without sufficient regard for the convenience of its master's competitors.

John C. Trautwine, Jr.

257 So. Fourth St., Philadelphia, Dec. 7, 1911.

[Our correspondent speaks of "a Government Bureau offering its services gratis for the public good" and thereby reveals a fallacy which misleads many people at the present day; though it ought not to mislead any engineer. When a Government Bureau offers its services gratis for the public good, somebody has to pay the cost of performing that service. There is no economy or advantage in robbing Peter to pay Paul, or in making a gift to a certain small part of the public for which the whole public have to pay in taxes.

There are certain tasks which the Government, federal, state or municipal can perform better and more economically than any private organization. There are other tasks where the Government or any large organization is absolutely incompetent to carry on business as economically as the individual.

For illustration, the Government owns enormous areas of lands suitable for farming, grazing, timber culture, etc. The railway companies of the West also own great tracts of valuable lands. If our correspondent's broad generalization as to the advantages of socialism over individualism were true, then the Government and the railway companies ought to at once put these lands into use, hiring managers, superintendents, overseers, farmers, laborers, etc., and making huge profits from the operation to provide us with that "wealth in store for us all" to which our correspondent refers. But wherever this experiment has been tried on even a small scale, it has proved a financial failure.

The great railway corporations are probably the best managed of all large organizations, and they have found by experience that they can buy cars and locomotives and a hundred different supplies far cheaper than they can produce them for themselves.

As for the big industrial trusts, there is a long list of them which have gone to the wall because they could not meet the competition of small independent well-managed rivals.

Finally, we have at no time admitted that the individual engineer had no chance against the competition of the Roads Office. On the contrary, we urged and believe that if it were once attempted to carry on the engineering work of the nation from a headquarters in Washington and the actual cost of the work, traveling expenses, etc., were charged against each job, the individual engineer would win, hands down.—Ed.]

"Mushroom" a Trade Name.

Sir: The writer noted in yours of Dec. 14, p. 717, a description of the failure of a building in Indianapolis, in which the building is described as a type of construction of "columns with mushroom heads."

As the writer has taken pains to register as a trade-mark the term "mushroom" as applied to his construction, he wishes to file an objection to the reference to such a miserable imitation of the "mushroom" head as shown in Fig. 2 of your issue. A reference to this construction applying or using the term "mushroom" becomes a libel of the trade-mark, which the writer trusts your spirit of fair play will promptly correct.

There are a number of extremely dangerous types of girderless floors that are now being put out as imitations of the "Mushroom System," patented by the writer. Some are advertised as "just as good," as was this design in Indianapolis. Others which are fully as dangerous have been advertised as an improvement on the "Mushroom System."

To any one who has ever seen a "Mushroom" design approved by our Minneapolis office, the idea that the "Mushroom" head could wilt and the rods forming the frame could be made to look like limp shoe strings dangling from the top of the head as shown in Fig. 2 of your issue would appear preposterous.

The trouble with this design is made clear by the figure. The dangerous character will be evident at a glance to any who have had legitimate experience with "Mushroom" construction.

C. A. P. Turner.

Minneapolis, Minn., Dec. 16, 1911.

[As the article in question said "the type of construction was of columns with mushroom heads and girderless floors patterned to some extent after the Turner 'Mushroom' system, but not in any way involving C. A. P. Turner, of Minneapolis, unless it be as a possible infringement of certain patents," we think that our "spirit of fair play" has been sufficiently demonstrated.—Ed.]

Notes and Queries.

W. J. R. inquires of us if there are any authentic data concerning the use of salt or calcium chloride in concrete which contains reinforcement, particularly as to the effect of these salts on the reinforcement in concrete in which they are used. So far as we know there have been no tests which throw much light upon the subject, but we would be very glad to hear from any of our readers as to their experiments or experience in this matter.

The Pittsburgh, Pa., "City Measure" mentioned in our issue of last week in the article on "Resurveys of City Lots" by Mr. A. E. Duckham, is a 10-ft. brass-bound wooden rod in the city engineer's office, not a 25-ft. rod as stated by Mr. Duckham. The rod is ¼-in. too long making 1¼ in. or 0.10 ft. per 100 ft. as noted. The State Legislature is the authority for legalizing this measure and not the city officials, according to Mr. Emile Low, M. Am. Soc. C. E.

There was also a typographical error in the article in the statement that the city allowed an excess of 10 ft. per 100 ft., which of course should have read 0.10 ft. as is plain from the following text.

The flood conditions on the Cedar River, near Seattle, Wash., described at length in our issue of Dec. 14, 1911, stopped traffic on the Chicago, Milwaukee & Puget Sound Ry. only ten days, instead of two weeks, as stated in the article. The difference may seem immaterial at first thought, but from the viewpoint of railway operations it is very considerable.

The note on the stadia tape in our issue of last week, p. 736, wrongly credited to Mr. W. Newbrough the description of the stadia rod in our issue of Nov. 23, p. 624. The description of this rod was sent to us by an engineer of the United States Geological Survey, Washington, D. C.

The New York State Barge Canal Terminal proposition, providing for an appropriation of $19,800,000 to be applied to the construction of terminals to the canal, was approved by a vote of the people of the State on Nov. 7. The result, as just announced by the State Board of Canvassers, shows the majority in favor of the proposition to be 4,416 out of a total of 627,448 votes cast. The favorable votes were cast only in those counties bordering the canal and particularly in those localities where the money for terminals is to be spent. New York City, where over one-half of the appropriation is to be spent, gave a majority of over 50,000 in favor of the proposition. At the same election the constitutional amendment, providing for the restriction of the canal terminal lands to the use of the State, was defeated by a majority of 41,572.

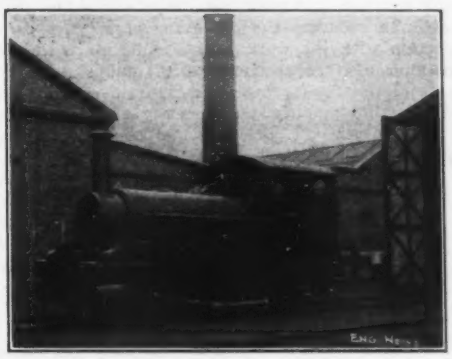
Snow Melters are a feature of the terminal yard of the new Chicago & Northwestern Ry. passenger station at Chicago. They are provided at various points outside of the trainshed to provide for rapidly disposing of accumulations of snow. As described by Mr. W. C. Armstrong, Terminal Engineer, in a paper read before the Western Society of Engineers, they consist of steel pans 3 x 6 ft. with semi-circular bottoms and containing perforated steam coils. They are set in the track floor and have removable steel plate covers flush with the tops of the ties. They are provided with drain pipes which connect with the sewers and carry off the water. After a snow storm, the snow removed from the tracks will be deposited in these pans and thus melted by the steam from the pipes.

Authority to Make Plans for Garbage Reduction Works for the District of Columbia is asked in the annual report of the District Commissioners, submitted to Congress early in December, 1911. The Commissioners also state that a partial investigation of the subject leads them to believe that the District could collect refuse cheaper than it is now being collected by contract. The present contract does not expire until June 30, 1915. During the year ending June 30, 1911, 48,217 tons of garbage were collected and disposed of at a contract price of $68,400; 95,785 tons of ashes were collected at a contract price of $73,150; 108,789 cu. yds. of miscellaneous refuse were collected at a contract price of $17,060; 28,834 bbls. of night soil were collected at a contract price of $16,600, and 16,720 dead animals were collected at a contract price of $2,855.

The First Chinese Locomotive.

Some account of the first railway built in China will be found in our issue of Feb. 27, 1896, in which mention was made of the construction of the Chinese "Rocket," the first locomotive to turn its wheels on Chinese territory. We reproduce herewith an illustration and brief description of this locomotive taken from an article by Mr. Frank A. Foster, Assistant Professor of Mechanical Engineering at Tangshan Engineering College, Tangshan, North China, in the November issue of the "Journal of the Worcester Polytechnic Institute."

In 1879 the only semblance of a railway to be found in China was a narrow-gage tramway about five miles long from the Kai Ping coal fields to a canal built from Pehtang at



The Chinese "Rocket"; First Locomotive Operated in China.

tide water on the Pehtang River to a place as near the mines as practical. This little road was operated by coolies pushing the cars. The China Merchants Steam Navigation Co., owners of the mines and tramway, had been refused permission to build a railway from Pehtang to the mines, a distance of thirty-odd miles.

At this time Mr. Claude W. Kinder, M. Inst. C. E., was made Chief Engineer of the company, and he quietly went to work to modernize its transportation facilities. He widened the gage to standard 4 ft. 8½ ins., and, it being impossible to import a locomotive, he set about the task of building one with such material as he had at hand.

For a boiler he used one belonging to an old hoisting engine outfit, cylinders came from the same source, while for wheels he was fortunate enough to find some old American car wheels. All these mounted on a frame made of channel bars from one of the mine shafts produced the locomotive shown in the accompanying illustration, at a total cost of from $350 to $400 gold.

When report reached the government officials at Peking that so pestilent a thing was in existence, a commission was sent to investigate. But there was some delay in its arrival, and the builders being forewarned succeeded in getting the locomotive out of sight by burying it in the ground. The royal commission arrived and investigated and returned with a report that no locomotive could be found.

It was not, however, until after considerable negotiation with the late Chinese statesman, Li Hung Chang, that the company officials found it safe to resurrect the Rocket from its resting place and put it into service where it did good work for several years. It is now in the shops of the Imperial Ry. of North China at Tangshan, where Mr. Foster obtained the photograph.

The Portable Emergency Hypochlorite Water-Disinfecting Plant of the Kansas State Board of Health.[1]

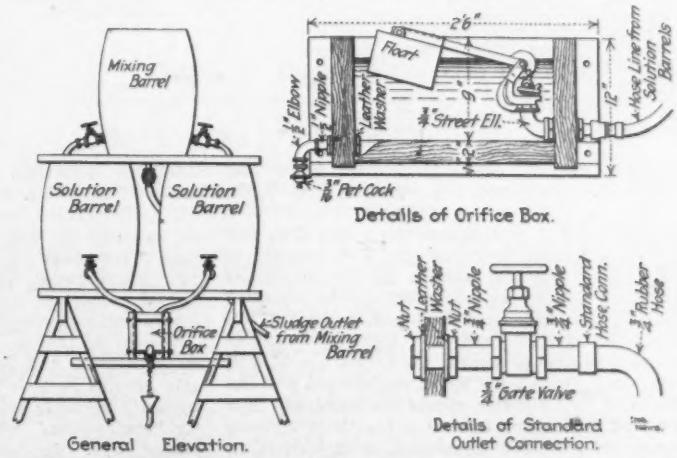
By W. C. HOAD.[2]

The State Board of Health now has a portable plant for the treating of municipal water supplies with calcium hypochlorite. It consists essentially of three substantial oak barrels, a specially-designed orifice box, and the necessary valves and connections. See details presented herewith.[3]

In operating the plant a calculated amount of the calcium hypochlorite is first dissolved in the mixing barrel and the solution is then drawn off into one of the solution barrels. This is done by gravity, as shown in the general view in the drawing, if circumstances permit; if lack of space renders this arrangement impossible, the mixing barrel is set on the floor and the prepared solution is pumped into the solution barrel by means of a small hand force pump, not shown in the drawing. The outlet connection to the solution barrel is then opened and the solution flows into the orifice box, where it is maintained at a constant level by the float valve. The pet cock at the outlet of the orifice box is then opened sufficiently to permit the required rate of outflow, this being adjusted by testing with a glass graduate. The solution thus measured out falls into a funnel, from which it is carried to the water supply through a suitable pipe. While the first barrel of the solution is being drawn off, a second charge is dissolved in the mixing barrel and run into the second solution barrel, to be used in turn.

It is expected that this plant will be held at the office of the engineer, at Lawrence, for emergency use over the state in connection with threatened or actual infection of public water supplies. The plant is capable of treating with hypochlorite any city water supply in the state.

A supply of hypochlorite is kept in jugs at the sanitary laboratory for immediate use. The plan is, should a water supply become infected, to ship the hypochlorite plant to the city threatened, set it up and begin at once to sterilize the supply. The plant would be accompanied by some one from the office of the State Board of Health, who would set it up properly and instruct the attendant in its use, or would remain during the entire treatment of the water, should this be necessary. A sufficient quantity of hypochlorite would be taken along to insure the continuous operation of the plant until more could be received by direct order from the city. It is not expected that the plant will be loaned to any city indefinitely, the intention being to hold it in readiness for such emergency services as may be required.



PORTABLE EMERGENCY HYPOCHLORITE WATER DISINFECTING PLANT, KANSAS STATE BOARD OF HEALTH.

Lectures on Various Municipal and Related topics, to be delivered on application before improvement and other associations, at St. Louis, Mo., have been arranged for by the Civic Club of that city, 911 Locust St. A neat pamphlet has been issued, showing by topics the subjects and speakers available. Some of the main topics are: Municipal Government, The City Beautiful, Health and Sanitation, and Recreation. The latter includes Park Systems.

[1] From the "Bulletin of the Kansas State Board of Health for August, 1911.

[2] Engineer, Kansas State Board of Health, Lawrence, Kan.

[3] For illustrated description of Minnesota State Board of Health Plant, see Eng. News, April 6, 1911.

The Collapse of the Reinforced-Concrete Building for the Prest-O-Lite Co. Under Construction at Indianapolis, Ind.

By THEODORE L. CONDRON,* M. Am. Soc. C. E.

An engineer cannot undertake to investigate and report upon such a calamity as the collapse of the Prest-o-Lite Co.'s building at Indianapolis, Ind., Dec. 6, 1911, in which nine or ten lives were lost, and many more unfortunate men were seriously injured, without having the profoundest regard for the great responsibility that rests upon all who undertake to design, direct or execute the construction of buildings and other structures. It is because the men who engage in such undertakings are often wofully ignorant of the fundamental principles of stresses and strains and of strength of material that such shocking disasters occur. In this instance no unusual nor unpreventable condition, such as a great storm, or flood, or earthquake, or an explosion, caused this structure to fall. But, without any such cause, suddenly and without warning, in the middle of a bright and pleasant winter's day, this mass of concrete materials and steel crashed to the ground, burying between 30 and 40 victims like some huge trap. It must not be accepted that no explanation can be found for such a collapse, for, if that were true, then we would be powerless to guard against the recurrence of such disasters. There must be an explanation and the lesson of this disaster should go broadcast over the land, a warning against a repetition of such dangerous practices as brought on this shocking collapse.

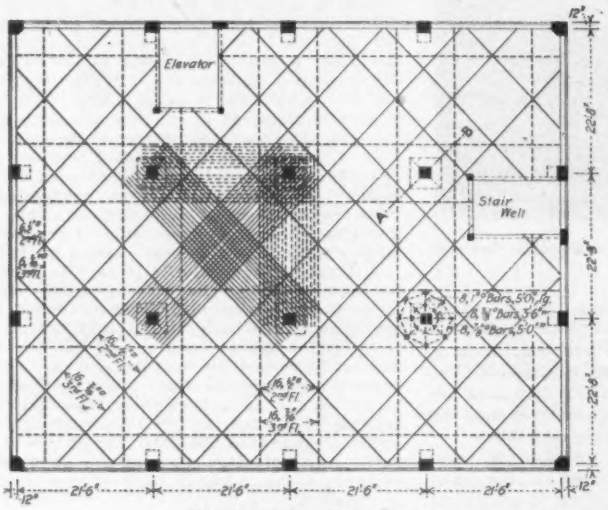


Fig. 1 Typical Floor Plan

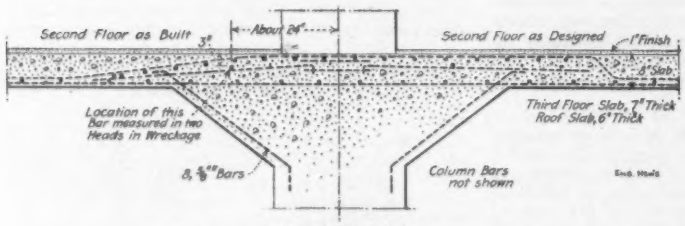

Second Floor as Built
About 24"
Second Floor as Designed
1" Finish
8" Slab
Third Floor Slab, 7" Thick
Roof Slab, 6" Thick
Location of this Bar measured in two Heads in Wreckage
Column Bars not shown

Fig. 2 Section A-B Enlarged

FIGS. 1 AND 2. TYPICAL FLOOR PLAN AND SECTION THROUGH COLUMN, SHOWING COLUMN-HEAD AS DESIGNED AND AS BUILT.

An investigation of the history of this particular contract shows that it was like scores if not hundreds of others entered into and carried out annually in our country. An architect, engaged by the owners, prepared plans and specifications for a building, intended simply to house a manufacturing plant, where the problem involved no architecture, so far as the "fine art" is concerned, as the building was to be on the back of a lot surrounded by four alleys. All that was needed was strength of construction, combined with weatherproofing, plenty of light, and simple sanitary fixtures. The architect's plans were doubtless prepared with usual care and intelligence, but his plans were not used. The invitation to bidders stated that bids would be received upon the architect's plans or on alternate plans which the bidders might submit for "flat slab or mushroom type of construction." Under this clause the successful bidder put in his bid accompanied by plans prepared by a local representative of a firm engaged in selling reinforcing bars.

This representative was an engineer who would prefer to act as engineer for owners or architects but finds, in his territory at least, the services of an engineer on building construction must be furnished "without expense to the architect," and consequently his business now is to furnish reinforcing bars at a low price and "throw in the plans." If he can devise plans that call for less concrete and steel than anyone else, he succeeds in securing the order for bars. His connection with the work begins and ends with the making of these economical (?) plans and the sale of the reinforcing bars. Whether his plans will be intelligently and honestly carried out, is not his concern. Once his plans have been approved and accepted by the architect it becomes the duty of the architect to see that they are followed. The architect, not being an expert, may be unable to pass upon the adequacy of the plans in the first place; and in the second place he may, and often does permit modifications in the construction which would not be sanctioned by the designer. The practice is pernicious and the wonder is that it does not more often result in failures.

The engineer should always be the agent of the responsible party. If he is the agent of the *owner* he will study the *owner's* best interests and use his ability to save the *owner* needless expense, and be free to advise the *owner* against reckless and dangerous economy. He will be the agent of the owner if he is employed by the owner directly or by the architect acting for the owner. A contractor may employ an engineer, or an engineer may be a contractor, in which case the engineer is not the agent of the owner, but will exercise his ability to save the *contractor* needless expense and advise the *contractor* against reckless and dangerous economy.

Where the contractor undertakes to build upon his own plans and guarantees to the owner certain results, it is safe to assume that the contractor's estimate includes a reasonable amount for "engineering," which amount, of course, the owner pays. In fact, the owner pays in any case, the only difference is that the engineer may be studying the owner's or the contractor's interests, depending upon who employs him. In work calling for the training and experience of an engineer, an engineer should be employed. No engineer desires to rob architects of their legitimate work, but many architects endeavor to cover all branches of engineering, about which they cannot well be informed.

Returning to this particular disaster, it is of first importance to consider the floor plans upon which the structure was being built. Such a plan, Fig. 1, has been prepared from the following information, obtained by Engineering News through Olney J. Dean & Co., of Chicago, who furnished the reinforcing steel and who state that although the plans were made by their Indianapolis representative, Mr. Hugh [illegible] Baker, they checked and approved them. This description has also been submitted to Mr. Baker and approved by him.

General Statement.

The building covered 70 × 88 ft. and was three stories high, without a basement; the bays were 22 ft. 8 ins. × 21 ft. 6 ins. c. to c. of columns. The columns were 22 ins. square for the first story; 18 ins. for the second story and 14 ins. for the third story; they had rectangular flaring heads or capitals, these having a spread of 20 ins. beyond the columns and a depth of 18 ins. The assumed live loads were 250 lbs. and 150 lbs. for the second and third floors respectively; the dead loads were 96 lbs. and 84 lbs. for the second and third floors respectively and 134 lbs. for the roof, including a slope of cinders covered with a tar and gravel roofing. The floors and roof were continuous slabs without any girders, except the wall spandrels; their thicknesses were 8, 7 and 6 ins. respectively. A top finish, 1 in. thick was put on the second floor, making the total thickness 9 ins. It is noted that in the failure, the slabs did not always fail at the junction of the slab proper with the column head—which may be regarded as the critical region—but in several cases the failure was a vertical shear through the column head, in line with the face of the column.

The steel reinforcement of the slabs was cold-twisted mild steel bars, the bars being ½-in. square for the second floor, 7/16-in. for the third floor and ⅜-in. for the roof. The bars were arranged in rectangular and diagonal belts between columns. The rectangular belts kept at the bottom of the slab while the diagonal belts were raised to the top of the slab over the column heads. In the floors these belts consisted of 16 bars spaced about 7 ins. apart (that is, eight bars on each side of the center line). Along each wall was a belt of six lines of bars spaced 9 ins. The bars of adjacent panels were lapped so as to form continuous lines from wall to wall. These lines were interrupted by two openings (in separate panels) one for elevators and the other for a stairway. Each of these openings had its two interior corners supported on light columns. Across the heads of the main columns the plans called for the diagonal bars to be bent up so as to lie near the top of the slab, the bend occurring in the slab proper (beyond the column head). This detail was not followed, as shown in Fig. 2. The arrangement in the roof was similar, except that there were 15 bars in each rectangular and diagonal row, with five bars (11 in. spacing) along the walls.

The column bars extended above the floor line, and were held by two hoops in the column head and other hoops below. Near the faces of the column head were eight ⅝-in. knee-brace bars, with the upper and lower ends bent to a horizontal and vertical position so as to lie within the floor slab and column respectively. Over each column head, and lying near the upper part of the slab (but beneath the diagonal bars) was a circular reinforcement or "spider" consisting of eight 1-in. radial bars and ⅝-in. inner and ⅞-in. outer cross bars, forming octagons. The center of the "spider" is a detail which was used in this building for the first time, and consisted of two flat plates bolted together. The ends of the radial bars were bent vertically and held in holes in the bottom plate; the upper plate lay on the bars to hold them in place, being secured to the lower plate by a central bolt. This arrangement was used to insure correct position of the spider.

It is stated the stress in the bars was not to exceed 16,000 lbs., and was actually less than that.* The test bars are reported as having an elastic limit above 61,000 lbs. The shear (for steel and concrete combined) it is stated was 80 lbs. for the second floor, 66 lbs. for the third floor, and 57½ lbs. for the roof. The compression is given as 500 to 600 lbs. The moment formula used was as follows (and was used for square-head instead of circular-head columns):

L = span one way.

B = span second way.

*Consulting Engineer, 1214 Monadnock Block, Chicago.

*The determination of the stresses in this design will be discussed by the writer in a later issue.

F = width of band = 7/16 L.
f = fiber stress of concrete in shear = 80 lbs.
T = total thickness of slab.
W = total load.

$$M = \frac{W \times L \times 12}{25}.$$

$$As = \frac{M}{0.88 \times d \times fs}.$$

$$\text{No. of bars per band} = \frac{As}{4}.$$

$$\text{Diameter of cap} = \frac{W}{3.1416 \times T \times V}.$$

Concrete was poured Oct. 23 and 24, Nov. 11 and 14, and Dec. 2 and 3 respectively, for the second and third floors and roof. The centering of the second floor was removed about Nov. 15, but a shoring of one post per panel was kept under this floor. At the time of the accident, the forms and centering of the third floor and roof were in place. For raising the concrete, the contractor built a tower in the elevator shaft of the building, the concrete buckets being raised to a considerable height above the work and poured through inclined chutes where required. After the completion of the roof, this elevator plant was used also for raising and depositing the cinders to be used in covering the roof. It is assumed that these cinders may have been piled up so that they imposed excessive loads upon the green concrete or centering. If the roof then gave way at any point (due perhaps to some permature removal of centering), the falling material would probably break through the floors below. In substantiation of this theory, it is stated that masses of cinders were found beneath the wreckage, indicating that this material had fallen through the first gap and that the complete wreckage had followed it.

It is stated further that men working on the first floor heard a crashing or crushing sound above them and rushed out in time to escape.

Concrete Work.

Unfortunately the writer is not able to express an opinion on the condition of the concrete of the third floor, as that material had been removed from the premises when he visited the wreck, but from all that he saw and heard it appears that the concrete of that floor shattered all to pieces in the collapse, although he was told that some pieces as large as 2 ft. by 4 ft. or 5 ft. held together. The second floor was not so shattered, but collapsed in large pieces or sheets. All agree that the roof concrete, which was three to four days old, had absolutely no strength. It is interesting in this connection to note the weather conditions as shown in the diagram, Fig. 3. When the second floor was poured the temperature was above freezing, in fact on Oct. 24 the temperature rose from 35° to 56°. During the next 18 days the temperature remained above freezing both day and night with the exception of three days. During these days the temperature was above 40° nearly all of the time and rose several days above 50°, going up on Nov. 11 to 73°.

On the night of Nov. 11 occurred the most remarkable drop in temperature throughout this entire part of the country ever recorded by the Weather Bureau. Duing that day the temperature rose from 51° to 73° and on this balmy day more than half of the third floor concrete was poured. The Weather Bureau had been sending out special warnings for several days of the phenomenal cold snap that was coming, so that shippers of fruit and others engaged in work affected by cold weather had ample warning. That night the temperature dropped to 14° and the next day (Sunday) was bitterly cold. On Monday morning, Nov. 13, the temperature was 12°, with a maximum of 28° during the day. From that day till December 6, when the failure occurred, the temperature during the night went below freezing every night except on Nov. 27, when the minimum was 36°. It would appear that the concrete poured Nov. 11, on the third floor, froze that night and the next day, after having taken its initial set, and probably suffered permanent injury, or at least was in such condition that it would take it a long time to set up. No doubt some parts would set up more than other parts. Attention is called to the fact that the second story columns seem to have set up quite hard, except that the caps of these columns proved to be very weak. The concrete in the shafts of the columns would be better protected than the column heads or slabs.

Had the concrete of the third floor been heated it would have set up so hard in a few hours that the cold would have no effect on it. And in view of the fact that the material must have been entirely free from frost, it would have been an easy matter to protect the concrete by covering it with building paper and straw or shavings, and with heat from numerous salamanders there should have been no trouble in keeping this concrete from freezing.

Cause of Failure.

The failure is variously attributed to lack of sufficient strength in or the disturbance of the form work; to insufficient strength in the second floor to sustain the weight of the concrete and form work of the third floor and roof (for single wooden posts in each panel here would not add much security if the concrete slab was not strong enough to carry the imposed load); to a partial removal of the form work under a section of the third floor (which was 22 days old) and that section, being incapable of supporting its own weight and the weight of the roof and roof form work, fell, after which failure the entire building collapsed. To support this theory it would be necessary to establish the fact that men were working on the second floor. The carpenter foreman was among the killed, and he may have started men striking the third floor forms. Certainly under proper conditions the third floor concrete should have attained considerable strength in 22 days. If proper means were taken to protect this concrete from freezing,* its lack of strength would be due to inferior materials or too little cement. Owing to lack of regular

*That it is possible to erect concrete buildings in the winter with speed and safety, is being daily demonstrated all over our country and in Canada. As an illustration, at the same time that this building was under construction in Indianapolis, a building of almost identical size and of flat slab design was and is under construction in Chicago, nearly 200 miles further north. On Dec. 6 all of the framework had been removed from under the fourth floor, which was poured Oct. 24, and only a few shores or posts were left in place under the fifth floor, which was poured Nov. 1. On Dec. 7 the contractor began taking out forms from under the sixth floor, poured Nov. 17 (age 18 days), leaving some of the posts in place as a safeguard. On that date the seventh and eighth floors were fully supported by falsework, while on Dec. 18 he began removing the forms from under the seventh floor (age 23 days). This has been possible and safe because under the specifications and supervision, all of the sand and gravel as well as the water for the concrete was heated by live steam before going into the mixer, and the concrete was delivered upon the floors steaming hot. In addition to this a steam hose and jet has been used to clean off the forms and take all frost out of the steel bars before pouring the concrete. Salamanders are used to warm the air under the floor after the concrete is poured, and canvas curtains are hung on the north and west sides of the building to keep out the wind. The benefit derived from salamanders is a doubtful quantity, but the expense is great. One dollar expended in heating the sand and gravel or stone with steam before mixing is worth ten dollars spent in heating cold concrete with salamanders.

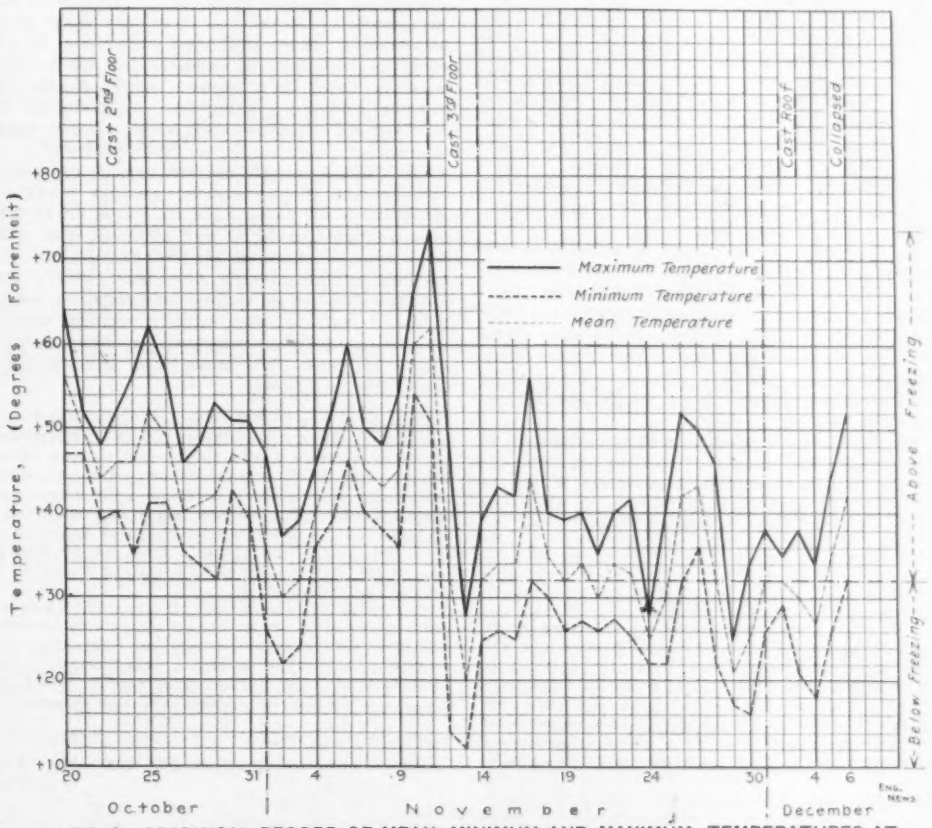


FIG. 3. GRAPHICAL RECORD OF MEAN, MINIMUM AND MAXIMUM TEMPERATURES AT INDIANAPOLIS FROM OCT. 20 TO DEC. 6, 1911.
(From Records of United States Weather Bureau.)

TABLE I.

	Prest-O-Lite Bldg. 2nd floor.	Prest-O-Lite Bldg. 3rd floor.	Taylor & Thompson Example.	McMillan's Examples. McMillan.	McMillan's Examples. Turner.
Col., spacing	22 ft. 8 ins. x 21 ft. 6 ins.		17 x 17 ft.	20 x 20 ft.	20 x 20 ft.
Diagonal	31 ft. 3 ins.		24 ft.	28 ft.	28 ft.
Live load	250 lbs.	150 lbs.	200 lbs.	200 lbs.	200 lbs.
Slab thickness	8 ins.	7 ins.	8 ins.	8 ins.	8 ins.
Diam. Col. head	62 ins. sq.	58 ins. sq.	54 ins.	60 ins.	?
Sect. one dia. belt	4.0 sq. ins.	3.06 sq. ins.	2.04 sq. ins.	3.14 sq. ins	1.87 sq. ins.
Sect. one rect. belt	4.0 sq. ins.	3.06 sq. ins.	2.04 sq. ins.	3.14 sq. ins	1.87 sq. ins.
Sect. of all bars over Col. head*	22.24 sq. ins.	18.48 sq. ins.	16.32 sq. ins.	31.36 sq. ins.	21.20 sq. ins.
Lap of bars over head	3 ft.	3 ft.	10 ft.	?	?
Width of belts	8 ft. 9 ins.	8 ft. 9 ins.	5 ft. 10 ins.	8 ft. 9 ins.	9 ft. 9 ins.

*This total section includes the areas of all bars cut by circle, circumscribed about the column center with a diameter greater than the width of the belts of bars, and includes the section of radial bars where they are shown.

supervision these are difficult questions to answer. No matter what the exact cause of the failure, it shows deplorable ignorance or recklessness on the part of those in responsible charge.

Regarding the design of the floor, the designer states that he followed the recommendations of Mr. Angus B. McMillan, as given in his paper read before the National Cement-Users' Association, February, 1910.* The writer is somewhat uncertain what Mr. McMillan's recommendations are after rereading his paper. However, Taylor & Thompson have published a method of analysis for flat slabs reinforced in the way these floors were reinforced, and they give an example to illustrate their theory.*

The table on page 781 shows a comparison of what the design for the Prest-O-Lite building and Taylor & Thompson's example and McMillan's examples is interesting.

From this table it will be seen that the design of the third floor particularly, was exceedingly bold if not worse, for a slab thickness of only 7 ins., with a diagonal span of 31 ft. is perhaps tempting fate, although the strength developed by flat slab floors under test loads has led everyone who has investigated the subject to revise their views. Nevertheless, floors should be so designed that the difficulties of placing the reinforcement will be duly considered and a fraction of an inch displacement of bars may upset one's fine calculations as to strength. Fig. 2 shows how far from the designer's proposed arrangement of the reinforcing the actual placing of the bars probably was.

As the writer interprets Mr. McMillan's method of designing floors, he brings all of his reinforcing bars to the upper part of his slab, while Taylor & Thompson recommend keeping the rectangular belts in the bottom of the slab. This was the arrangement adopted by this designer, and thereby he loses the tension value of those bars over his column head where the tension stress is greatest.

Mr. C. A. P. Turner has always carried all of his bars over the column head as near the top of his slab as possible, which seems to be the rational way to do. Perhaps it is to avoid infringing Mr. Turner's patent that only half of the bars are so placed in this design.

[To be continued in our next issue.]

The New York, New Haven & Hartford R. R. Co., acting with the controlled Connecticut Co. and the Housatonic Power Co., is reported to have practically given up the gas and electric-lighting business which has been gradually acquired in towns along its lines. This move takes the form of a sub-lease to a corporation known as the United Electric Light & Water Co., generally believed to represent the United Gas Improvement Co. of Philadelphia. The sub-lease to this company covers all properties except those used for railway purposes in the towns of Waterbury, Naugatuck, Watertown, Cheshire, Norwalk, Wilton, New Caanan and Greenwich. The sublease is made to the United Electric Light & Water Co. for 994 years. Enforcement of the obligation is secured by a bond of $500,000; default of payment for 30 days cancels the sublease. The lessee pays taxes and fixed charges, leaving some $365,000 annual net to the New Haven Company. This move is said to be in accordance with a policy of the company to dissociate itself from all industrial enterprises not directly connected with transportation.

Postal Underground Railways.—The report of the London Traffic Branch of the Board of Trade, published last week [Cd. 5972], contains an account of the findings of a Departmental Committee appointed by the Postmaster-General to consider the question of the transmission of mails in London by pneumatic tube or electric railway.

The committee, which reported last February, recommend electric railways in tubes 7¼ ft. in diameter, laid in the London clay and accommodating two tracks of 2-ft. gage. They are in favor of motor wagons, in preference to locomotives and trailers, each pair of wheels to be fitted with a motor designed to develop a maximum speed of about 35 mi. per hr.

They propose in the first instance a line 6½ miles long, starting at the Eastern District Office and passing to the General Post Office and thence to Paddington Station. The cost of construction is estimated at $2,500,000, and it is considered that the line would be amply justified on grounds of economy alone.—London Times.

*Engineering News, March 31, 1910.

A Plea for Measured Charges for Water and Other Public-Utility Services.

A valuable paper on "Water Rates" was read last June before the American Water Works Association by Mr. Geo. G. Earl, M. Am. Soc. C. E., and was abstracted at length in our issue of July 20, 1911. Mr. Rudolph Hering, M. Am. Soc. C. E., has recently submitted for publication in the Proceedings of the Association a written discussion of Mr. Earl's paper. A portion of Mr. Hering's discussion is given below.

It may be stated here, for the convenience of our readers, that Mr. Earl analyzed water rates, dividing them into those that should be charged to the general public, or the city, and those that should be charged to private consumers, at the same time setting forth a basis for determining the division of the total yearly cost of waterworks between the two classes of consumers. Mr. Earl proposed that all water supplied to private consumers be metered and that there be a single meter rate for all consumers, regardless of the quantity consumed. In order to adjust equitably the burden of private water service between small and large consumers, in accordance with relative expense involved, he proposed a fixed, or minimum, yearly charge for various classes of consumers, as indicated by sizes of service pipe—that is, a ready-to-serve charge.

Mr. Hering opens his discussion by warm endorsement of the general position taken by Mr. Earl in his paper. He then goes on to discuss the unfairness of flat rates, or the ordinary way of charging all consumers alike, regardless of the quantity consumed. While Mr. Hering's discussion relates primarily to water rates, it will be seen that it applies almost equally to flat-rate charges for other public-utility services. We quote from Mr. Hering's discussion as follows:

Flat rates are unfair, wasteful and unjust. In short, they are as inequitable for the distribution of water as they would be for distributing other commodities, such as gas, electricity, steam, milk and food. They place a premium upon waste, not upon economy. The wasted part of the commodity must be paid for by the careful and economical user, who is thereby actually fined for practicing one of the best qualities of a citizen living in a progressive community.

Flat rates have been, on the other hand, apparently justified and are almost exclusively used in America for city transportation. Carfares are generally placed at 5 cts. a ride, whether for one block or fifty blocks. This custom has been largely a matter of convenience and simplicity, not of justice. The excessive fare for a short ride pays the insufficient fare for a long ride.

That this flat rate for carfare will be eventually abolished, is my firm belief. It has already been done away with in Europe, where people cannot afford to waste in the manner we do in our country. The fare is adjusted somewhat to the distance traveled. Where one pays his fare at the station, as on their rapid-transit lines, the ticket is punched when passing the entrance gates. In addition to this practice, the European ticket is not collected until the passenger passes the exit gate. By the color or other sign, the collector quickly recognizes whether the passenger has paid the proper fare to the station where he has left the train. If he has gone beyond the point to which he is entitled to ride, he must stand aside until the crowd has passed and pay the difference, which generally includes a fine. Where one pays on trolleys, a slip of paper is given for the distance desired. Collectors or controllers enter the cars, check the slips and gather in the fines for over-rides. Some lines in America have already similar practices, excepting the exaction of fines.

With this arrangement, one can ride in England, France, Germany, etc., for 1 ct. or 1.4 cts. a distance for which many Americans would hesitate to pay 5 cts. and therefore prefer to walk, while the European corporation is apt to get a fare and, on the whole, to take in more money. Also in other respects the trolley services are generally superior. The flat-rate idea will never again be countenanced in Europe, even for carfares, as present practices are quite satisfactory.

Another injustice resulting from the adoption of the flat rate is seen when the owner of a large property pays a less tax per unit than the owner of a small property for the same unit, other conditions being equal. The tendency towards "wholesale rates" in this as in other municipal assessments is found in practice to virtually increase the taxes of the poor and to decrease the taxes of the rich.

The balance of Mr. Hering's discussion is an endorsement of the details brought out in Mr. Earl's paper, concluding with approval of Mr. Earl's assumption of a 20% allowance for the under-registration of water meters.

U. S. Census Bureau Summary of Irrigation Statistics for the United States, 1909 Compared With 1899.

A preliminary statement regarding the irrigated area of the United States in 1909, as compared with 1899, has been issued by the Bureau of the Census, Washington, D. C. The information takes the form of a table, and of text setting forth some of the leading figures in the table. We reprint the table herewith:

IRRIGATION STATISTICS OF THE ARID AND SEMI-ARID REGIONS OF THE UNITED STATES, 1909 AND 1899.*

	1909.	1899.	Increase. Number and amount.	Increase. Per cent.
Number of farms in arid and semi-arid region	[1]1,439,023	[2]1,095,675	343,348	31.3
Approximate land area of arid and semi-arid region (acres)	1,161,385,600	1,161,385,600	.....	...
Improved land in farms (acres)	[1]173,433,209	[2]119,709,592	53,723,617	44.9
Total value of farm land	[1]$10,488,460,215	[2]$3,249,259,472	$7,239,200,743	222.8
Average value per acre of farm land	[1]$26.99	[2]$9.42	$17.57	186.5
Number of farms irrigated	157,862	107,716	50,146	46.6
Acreage irrigated	13,739,499	7,527,690	6,211,809	82.5
Area enterprises were capable of supplying in 1910	19,335,711	(3)	.....	...
Area included in project	31,112,110	(3)	.....	...
Per cent. of number of farms irrigated	11.0	9.8	1.2	...
Per cent. of total land area irrigated	1.2	0.6	0.6	...
Per cent. of improved land in farms irrigated	7.9	6.3	1.6	...
Number of independent enterprises	[1]54,669	(3)	.....	...
Total length of ditches (miles)	[1]125,615	(3)	.....	...
Length of main ditches (miles)	[1]87,336	(3)	.....	...
Length of lateral ditches (miles)	[1]38,279	(3)	.....	...
Number of reservoirs	[1]6,933	(3)	.....	...
Capacity of reservoirs (acre-feet)	[1]12,872,256	(3)	.....	...
Number of flowing wells	[1]5,070	(3)	.....	...
Number of pumped wells	[1]14,544	(3)	.....	...
Number of pumping plants	[1]13,951	(3)	.....	...
Engine capacity of pumping plants (HP.)	[1]207,241	(3)	.....	...
Acreage irrigated with pumping water	[1]478,288	(3)	.....	...
Acreage irrigated with flowing wells	[1]125,590	(3)	.....	...
Total cost of irrigation systems	[4]$304,699,450	$67,482,261	$237,217,189	351.5
Average cost per acre	[4]$15.76	$8.89	$6.87	77.3
Aver. annual cost of operation & maintenance	$1.07	$0.38	$0.69	181.6

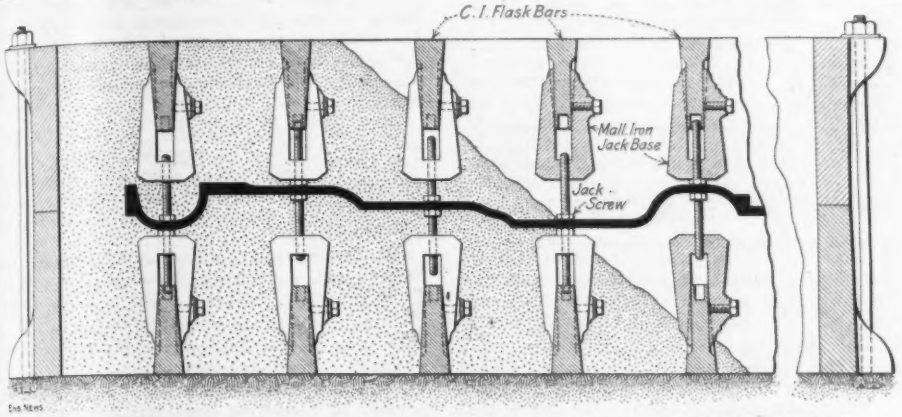
*The states included are Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, Wyoming, and part of Texas. In the rice belt of Arkansas, Louisiana and Texas, 4,320 farms and 694,730 acres were irrigated in 1909; also, in 1909, there were 2,228 farms and 28,919 acres irrigated in the humid states, mostly truck gardens.

[1]1910; [2]1900; [3]not reported; [4]based on cost of construction to July 1, 1910, and acreage enterprises were capable of supplying in 1910.

A Molding-Flask Attachment Designed to Prevent the Warping of Thin Castings.

Much trouble is experienced in making thin castings of large area on account of warping. Due to unequal cooling in different parts of the casting, it may twist or warp so badly as to become worthless. Many contrivances have been tried by foundrymen for preventing this warping but none has met with enough success to be generally adopted. Mr. Henry E. Thompson, of 253 Clinton Ave., Newark, N. J., has been using for the past twelve months a device of his own invention which is claimed to completely solve the problem for a large class of castings.

This invention consists of a cast-iron molding flask equipped with a number of "straddling abutments" resembling small jack screws which are clamped to the flask bars, both in cope and



SECTION THROUGH MOLDING FLASK, SHOWING CASTING HELD IN PLACE BY SCREW ABUTMENTS.

drag, and screwed down to such a position as to bear against the casting and hold it to shape while cooling. The abutments are adjusted to the proper position by bringing them up against the pattern before the sand is put in. Thus the bearing heads of the screws are flush with the surface of the mold when the sand is rammed around them. The accompanying illustration shows a sectional view of a mold with the abutments in place bearing against the casting.

In preparing the mold, the pattern is placed on a molding board and the drag set over it as usual. The divided bases of the abutments are then slipped over the cross bars and the jacks are roughly adjusted to the surface of the pattern before clamping them to the bars with the set screws shown in the illustration. By turning the screws, they are then brought into easy contact with the pattern and the drag is filled with sand and rammed. After turning over the drag and adjusting the cope, a second set of abutments is attached to the cope bars and brought up against the pattern as before.

To prevent the formation of fins around the edge of the casting at the parting line, Mr. Thompson uses thin plates of metal to separate the edges of the cope and drag during molding. These separators are removed before closing the flask after the pattern has been drawn out, and as a result the two parts of the mold are pressed tightly together when it is closed. Bolts are used, as shown in the illustration, to clamp the two parts of the flask together and insure a firm backing for the abutments.

As shown in the cut, the flask bars are of the usual tapering section, but wide flat-bottomed grooves are provided at intervals along each bar to receive the bases of the abutments. In the lower edge of the bars are holes corresponding with the middle of each groove to receive the points of the main screws. This permits the screw heads to be brought up close to the bars.

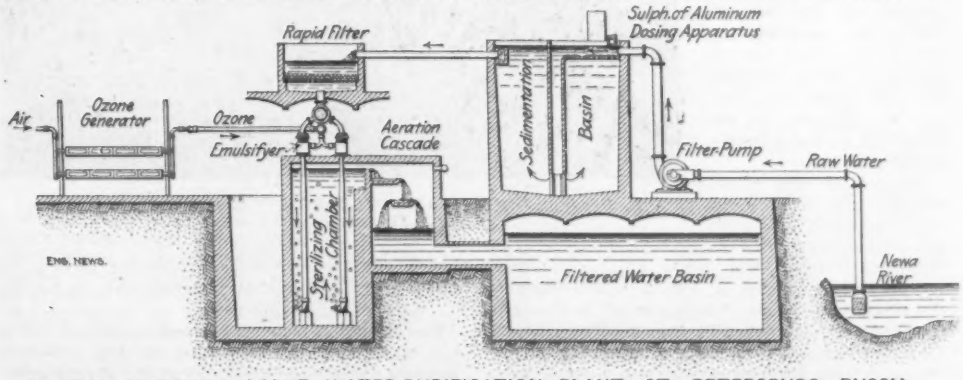
The bases of the abutments are made of malleable iron and the screws of wrought iron. Mr. Thompson is making arrangements to manufacture them in sizes ranging from 3 to 18 ins. in length, suitable for castings up to 20 tons in weight.

The most obvious objection to the device would seem to be the possibility of setting up serious strains in the casting by resisting its motion during cooling, but we are assured that hundreds of castings have been successfully made in this way at Mr. Thompson's foundry in Newark from patterns that would not yield satisfactory results by other methods.

The Ozone Water-Purification Plant at St. Petersburg, Russia.

In our issue of April 28, 1910, we described in some detail the progress of the application of ozone to the sterilization of water-supplies. Since that time one of the largest ozone installations in the world has been made at St. Petersburg, Russia. The apparatus used is in general of the type described in a portion of our previous article, but it may be of interest to engineers to abstract in brief the descriptions of the plant which have appeared in certain foreign publications.

St. Petersburg has been supplied with water from three large plants, of which one only has heretofore been furnished with any method of purification. The largest of the three passed the water of the Neva through sand filters, but the two others turned this raw water without purification into the distributing reservoirs. In one of the smaller plants, called the Penkowala, the new ozone purification process has been applied. This plant furnishes a section which consumes in round numbers about 13,200,000 gals.



SECTION THROUGH OZONE WATER-PURIFICATION PLANT, ST. PETERSBURG, RUSSIA.

per day. As is usual in such plants, the raw water is first clarified by a rapid filter, using sulphate of aluminum, which removes the suspended matter which is so abundant in the waters of the Neva.

As shown in Fig. 1, the raw water is pumped directly from the Neva into the so-called decantation or clarification basins. Before entering these basins the water is treated with sulphate of aluminum in a proportion not noted in any of our information. The treated water passes then through the settling tank under baffle-boards to an upper pipe, through which it is carried to the rapid filters, as shown in the figure. These filters, of which there are 38, are operated according to the Howatson system, and seem to be somewhat similar to the American Jewell filter, except that instead of sand, fine grains of flint are used for the filtering material. The filters are cleaned by reversing the current of water through them, and by the simultaneous agitation of the filter bed of flint stone.

After passing through the rapid filters, the water is then carried into tanks, where the ozone is applied. The ozone installation is subdivided into two distinct parts; the generation of the ozone and the application of the ozone generated to the prefiltered water. The 126 ozonizers, which generate the ozone, are of the well-known Siemens & Halske type, and are operated in connection with five Otto emulsifiers, which were described in the article in Engineering News previously noted. A concentration of 2½ grams per cu. m. is attained with this apparatus.

The electric generators produce a 250-cycle three-phase current, which is transformed to a single-phase current with a tension of about 7,000 volts. The steam installation consists of two 150-HP. engines, which not only drive the electric generating apparatus, but also the agitators and pumps connected with the prefilter system. The whole plant is housed in a large brick and concrete building.

The cost of the operation so far seems to run about $16 per 1,000,000 gals., of which the larger part is expended on the ozone process. From the bacteriological standpoint the results have been very satisfactory. The impure water of the Neva is transformed into a limpid water in which the number of pathogenic germs are extremely small. In no test since the plant has been under operation has there been any evidence of B. coli or cholera or "typhus" (typhoid?) germs.

Water Power Rights at Sault Ste. Marie Rapids in St. Mary's River at Sault Ste. Marie, Mich., are to be leased by the U. S. Government to the Michigan Lake Superior Power Co., and the Edison Sault Electric Co., according to current reports. The arrangement has not been officially announced and details are lacking. It appears that President Taft became interested during a visit to Sault Ste Marie last September, in the industrial situation which that place faced. Very recently further action was sought by Governor Osborne and Mr. Frank Knox, whereupon President Taft directed the Secretary of War to confer with them and with the Chief of Engineers, U. S. A., to see if it was not possible to give the locality the benefit of the water power without hindering navigation of the canals around the rapids.

The power development of the Michigan Lake Superior Power Co. was described in Engineering News, Aug. 4, 1898, Jan. 9, and Sept. 25, 1902. It appears that the company has constructed a large canal for conveying some 30,000 cu. ft. per sec. out of Lake Superior into the St. Mary's River for the development of about 50,000 HP., but that litigation and conflicting rights have prevented the use of this canal. It is contended that its use would greatly contribute to the prosperity of the locality. It is reported that the present arrangement is authorized by the River and Harbor Act of 1907, and will enable the companies to secure a clear title to water for power purposes and will permit them to enter into negotiation for the sale of power at a definite price and for a fixed period of years.

A Metal Flume Without Cross-Ties.

Open metal flumes are in a large measure replacing the heavy wood plank flumes which were once extensively built for mining, power and irrigation purposes. Aside from the increasing cost of lumber its use for this purpose has objectionable features arising from the alternate shrinking and swelling of the wood, and subsequent warping and distortion of the structure.

Metal flumes have been in use to some extent since 1891, when a galvanized-iron flume of parabolic or semi-circular cross-section was invented and patented by Mr. M. H. Laybourn.* It is interesting to note that this early design was constructed without cross-ties. The flume was supported by cast-iron side brackets of A shape bolted to a timber trestle. The trough of the flume was made of plates riveted together. It does not appear that this flume was used to

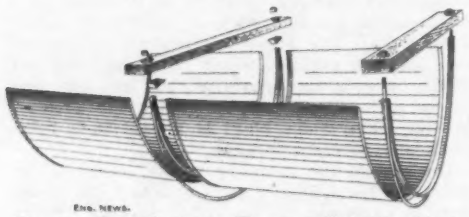


Fig. 1. The Maginnis Type of Galvanized-iron Flume.

any great extent, due probably to the difficulty of making so many riveted joints in the field.

An improved form of flume was invented and patented in 1902 by Mr. P. Maginnis, and is now much used in the West for irrigation purposes. In this design the trough is supported by iron ribs hung from timber cross-ties, which rest on the timber side supports. The joints are made by overlapping the plates, a small head on the lower plate fitting into a corresponding groove on the upper plate. The joint is then pressed firmly together between the two iron ribs as shown in Fig. 1.

A more recent type of galvanized-iron flume is that shown in Figs. 2 and 3. The chief feature of this design is the elimination of the timber cross-ties, the lateral support of the conduit being two parallel timbers which carry the rib brackets. These timbers and the stiffer ribs fulfil the function of the cross-ties of the previous design.

The plates are joined together by overlapping and pressure between two ribs, similarly to the Maginnis design. The lower rib is bolted or riveted to the bracket A, Fig. 2, which fits over the supporting beams. The upper rib is similarly fastened to the bracket B, Fig. 2. The ribs are drawn together by a bolt, pressing the overlapping plates together and giving a tight joint. Corrugated plates may be used with the corrugations running transversely to the axis of the flume.

The advantage claimed for the open type of flume without cross-ties is the lessened danger of the flume being obstructed by floating debris, which causes the flume to overflow and may undermine the supporting trestle work. Other advantages of metal flumes are their easy adjustment to curves and angles, the facility with which they may be taken apart and reassembled, or parts removed and renewed, and also the facility with which they can be packed for transportation.

The flume illustrated by Figs. 2 and 3 was invented and patented by Mr. William Lennon, of Manitou, Colo, and is manufactured by the Colorado Ingot-Iron Pipe & Flume Co., of Colorado Springs, Colo.

*Engineering News, Oct. 17, 1891.

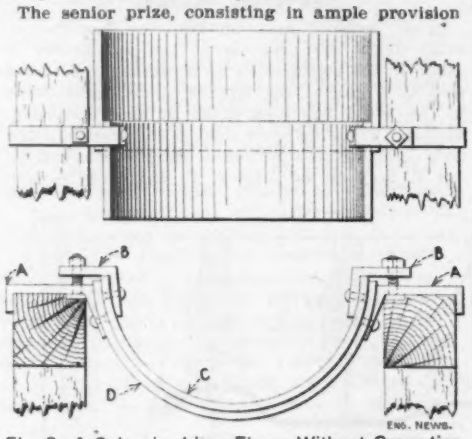


Fig. 2. A Galvanized-iron Flume Without Cross-ties.

FIG. 3. A LENNON GALVANIZED-IRON FLUME FOR IRRIGATION PURPOSES.

Notes From Engineering Schools.

THROOP POLYTECHNIC INSTITUTE.—An anonymous friend of the school, believing in the educational value of travel for engineering students, has established two prizes which are to be spent for extended trips.

The senior prize, consisting in ample provision for a trip to Europe, is awarded on each commencement day to that member of the graduating class who has the best record in scholarship for the junior and senior years, the faculty taking also into account, in assigning the award, considerations of deportment, or good manners, and ability for original work. No award shall be made, however, unless the faculty shall adjudge some member of the graduating class to be sufficiently distinguished in scholarship to justify it. This prize is $750 cash.

The freshman prize, consisting in full provision for a journey through some of the principal Eastern American cities, over a route recommended by the faculty, is awarded on each commencement day to that member of the freshman class who has the best scholarship record for the year, good manners and the quality of initiative being also taken into account. This prize is $250 cash. No award shall be assigned in case the faculty deem the record insufficient to justify it. The faculty may, in some instances, permit this prize to be used for other purposes than travel, but reserve the right to indicate the mode of its use in case of any such exception.

RENSSELAER POLYTECHNIC INSTITUTE.—The Department of Electrical Engineering has recently installed in the Russell Sage Laboratory an apparatus for testing electric railway motors under conditions closely approximating those found in actual practice. The equipment consists of two 60-HP. 600-volt commutating-pole railway motors mounted on a standard high-speed truck equipped with air brakes and a traction dynamometer. The truck wheels rest on and drive other wheels mounted on stationary bearings. A silent-chain drive connects the two friction-wheel axles so that they revolve at the same speed. Loads corresponding to rolling friction, grades and wind resistance are applied by means of a water brake of large capacity and a 6-ft. flywheel of variable weight allows the determination of acceleration corresponding to different car weights up to eight tons. Speeds of up to 35 mi. per hr. can be obtained. The controller, engineer's valve, compressor and measuring instruments are placed in convenient position near the truck. The work of connecting a series-parallel controller, the handling of the controller and air brakes and the determination of speed-time, current and power curves under various conditions form part of the regular work in the electrical engineering laboratories. The apparatus is also available for research in the performance of electric railway equipment.

FRANKLIN INSTITUTE; SCHOOL OF MECHANIC ARTS.—The Franklin Institute Alumni Association, organized by graduates of the school, is desirous of obtaining the addresses of all graduates and former students in this country and elsewhere.

The school was established in 1824 and has been conducted continuously since that time, graduating each year a number of students. The records on file at the Institute are incomplete, in that they do not contain the present addresses of many former students.

The Alumni Association was formed for the purpose of promoting closer relations among the graduates and by cooperation to further, if possible, the professional interests of each member. The officers recently elected are anxious to get into communication with the many graduates of the school who are scattered throughout the country with a view to presenting to them the objects of the association and the advantages of membership. Former graduates or those who may have any information relating to them are requested to communicate with the Secretary of the Association, Mr. Charles E. Hubsch, Franklin Institute, Philadelphia.

A Gas-Engine Flywheel Exploded, Dec. 13, in a grist mill near Bruin, Pa. Reports state that a large piece of the flywheel was thrown through the floors and ceilings of the two upper stories of the mill. The engine was of 125 HP.

Floods in Southern Wales along the River Avon have largely subsided according to press reports dated Dec. 19. The reports state that a number of bridges over the river were swept away and that hundreds of dwellings were inundated.

A Locomotive Boiler Exploded Dec. 14 at Glover Siding near Kamela, Ore., while the engine was helping an Oregon-Washington R. R. & Navigation Co. freight train up a heavy grade. The front of the boiler was driven through the caboose just ahead of it. One man was killed and two others were badly injured.

A Broken Rail is reported to have been the cause of the wreck of train No. 38, on the Seaboard Air Line Ry., Dec. 22, at Gloster, Ga. The train was derailed near the Gloster station while running at about 40 mi. per hr. About 40 persons were injured.

A butting collision on the Texas & Pacific R. R. near Texarkana, Tex., Dec. 22, caused the serious injury of some 30 persons. The accident is ascribed to the mistake of a negro switchman.

A Passenger Elevator Accident in the 18-story building at 24 Stone St., New York City, on Dec. 21, 1911, injured nine persons, seven of whom had one or both legs broken. The facts of the accident, as obtained from inspection reports of the Bureau of Buildings, are as follows: The elevator, one of a group of three, made a stop at the sixth floor on its way down. The operator tried to stop on the fifth floor but could not, and the car fell, landing on the bumpers at the bot-

tom of the shaft. The lifting cables, two ⅝-in. ropes, were found to have pulled out of the malleable-iron socket at the top of the car, and the cables were lying on the car. The counterweight consisted of two parts, the upper connected to the car and the lower to the electric hoist. The upper part was found at the top of the shaft, where it had smashed into the overhead work, while the hoist counterweight was at the 13th floor, having stopped apparently when the car was at the fifth or sixth floor. Marks on the elevator guides indicated that the safety clutch had gone into operation near the second floor. The elevator car was distorted by the fall, but one mirror and one electric lamp were not broken.

A Bridge Erection Accident on the West Jersey & Seashore R. R. at Haddonfield, N. J., on Sunday, Dec. 24, 1911, killed two men and injured half a dozen others. A force of workmen was hoisting a steel plate-girder span which was to replace a timber trestle; the old structure gave way under the load. The foreman of the erecting gang and one of the workmen were killed.

The Fall of a Roundhouse Roof at Altoona, Pa., on Dec. 26, 1911, caused injuries to a number of Pennsylvania R. R. employes. The building was old, and one of the roof trusses failed.

The Los Angeles Aqueduct is progressing at a rate which promises completion early in 1913. On Dec. 15, 1911, the last tunnel of the Little Lake Division, Tunnel 10A, was holed through. This tunnel, 5,960 ft. long, is fifth in length on the Aqueduct; the longest, the Elizabeth Lake Tunnel, 26,870 ft., was completed early in the current year. Tunnel 10A was begun March 10, 1910. Its completion leaves only about 4,000 ft. of tunneling to be done on the Aqueduct, out of a total of nearly 43 miles.

Indictments for the Austin Dam collapse were found by the Grand Jury, of Potter Co., Pa., at Coudersport, on Dec. 21, 1911, against Geo. C. Bayless, president of the Bayless Paper & Pulp Co., and F. N. Hamlin, the superintendent of the company's plant at Austin. Some days prior to this several damage suits against the company and Geo. C. Bayless had been started on the part of victims of the flood or their survivors.

The New Lackawanna Cut-Off between Hopatcong and Slateford, N. J., was opened for traffic on Dec. 24, 1911. This cut-off, as described at its inception in Engineering News of Aug. 13, 1911, p. 176, is 28½ miles long and shortens the main line of the Delaware, Lackawanna & Western Ry. between Hoboken, N. J., and Buffalo, N. Y., a little over 11 miles. In addition it reduces the maximum grade from 1.14% to 0.55% and the number of curves from 57 to 15. The relocation was accomplished only at very great expense, due to the heavy cuts and fills to avoid tunnels and to better grades and because of the massive character of the permanent structures.

A Low Price for Steel Springs has been obtained by the Isthmian Canal Commission on the steel springs for use behind the approach-wall fenders on the Panama Canal locks, illustrated in Engineering News of Nov. 2, 1911. There are 25,608 springs required, each 3 ins. inside diameter and 12¼ ins. long when free and weighing about 26 lbs., or a total weight in the entire order of 640,200 lbs. The Railway Steel Spring Co. has the contract to furnish the springs for 2.12 cts. per lb.

A Uniform System of Accounts for Telephone companies subject to regulation by the Interstate Commerce Commission is being arranged for by that body. Information on the subject is given in Accounting Series Circular No. 30, by Mr. Charles A. Luts, chief examiner of accounts.

The Commission Plan of City Government recently authorized by the legislature of Illinois, has been declared constitutional by the Supreme Court of that State.

Dams in New York State are in general in a somewhat unsatisfactory condition, according to a report of the newly-appointed Inspector of Dams and Docks of the State Conservation Committee. In two months' work, since October, 1911, he examined eight wooden dams, nineteen earth dams, sixteen solid masonry dams, and three buttressed reinforced-concrete dams. Two wooden dams were ordered rebuilt, one was an abandoned dam (in which case the reservoir was ordered emptied), and the other five wooden dams were ordered repaired. Of the earth dams, which ranged from 20 to 45 ft. high, a number have no spillways, and one had its spillway obstructed. One of the reservoirs was ordered emptied on account of weakness, and in eight reservoirs the water was lowered from 4 to 10 ft. in order to bring the dams within safe limits. Repairs and alterations were recommended for six, and one case was referred to the counsel of the Commission for action. The solid masonry dams, ranging from 10 to 54 ft. high, of which five are in process of construction, also showed many unsatisfactory conditions. Two reservoirs were ordered emptied, one on account of poor masonry and one on account of thin walls. In another the water was ordered lowered. Repairs were recommended for six. The three reinforced-concrete dams, ranging up to 30 ft. in height, were fairly good, minor changes being recommended in one. The Inspector reports that in many cases the earth dams showed no earth on the downstream side of the core-walls. It is not stated what prevents the failure of these dams. It developed that the owners of dams were in general ready and willing to carry out suggestions for repair or improvements.

A Committee on Standards of Purity for Rivers and Waterways has been announced by Mr. Calvin W. Hendrick, president of the National Association for Preventing the Pollution of Rivers and Waterways, and chief engineer of the Baltimore Sewerage Commission, Baltimore, Md. This committee was organized at the meeting of the Association held at Baltimore on Dec. 13, 1911. The committee was instructed to study in a broad way the subject indicated by its title and to make a tentative report at the next annual meeting of the Association. This report will deal with the question of the feasibility of establishing standards of pollution applicable to the conditions prevailing in various parts of the country. The names of the committee are as follows:

Mr. George C. Whipple, of Hazen & Whipple, 103 Park Ave., New York City; Dr. Edward Bartow, director Illinois State Water Survey, Urbana, Ill.; Mr. George M. Wisner, chief engineer Sanitary District of Chicago, Chicago, Ill.; Mr. H. W. Clark, chemist, Massachusetts State Board of Health, Boston, Mass.; Dr. A. J. McLaughlin, of the U. S. Public Health and Marine-Hospital Service, Washington, D. C.

The Ontario Hydro-Electric Power Commission will be transformed into a Department of Hydro-Electric Power, according to current reports. It is expected that the formal change will be made on May 30, 1912, at the close of the half-year of the Commission's business. The Hon. Adam Beck, present Chairman of the Commission, will continue to direct the work as head of the new department, carrying the official title of Minister of Power. It is stated that the organization perfected by the present Commission will be maintained, such changes as are necessary being changes in title rather than in personnel. The status of municipalities which have contracted with the Commission for the supply of power will not be altered. In place of such contracts the future agreements will be between municipalities and the Ontario provincial government.

The Manufacture of Gas, for both illuminating and heating, is the subject of a preliminary report by the U. S. Census Bureau, based on the figures of 1904 and 1909. A general summary of the data is shown in the accompanying table. The figures do not include gas made in coke and other establishments producing gas as a by-product, nor is there included producer or blast-furnace gas for power and furnace purposes made by establishments in which it is consumed. In computing the "cost of materials," figures for fuel, rent of power and heat and mill supplies are included. The "value added by manufacture" represents the difference between the above cost of materials and the value of products after passing through manufacturing processes. "Miscellaneous expenses" include rent of factory or works, taxes and amounts paid for contract work, as well as unclassified office and other expenses. It is seen that carbureted water gas was the kind most largely produced. A gain of 45% yas shown compared with a gain of 34% for all kinds of gas. The greatest percentages of increase in specified gases is that shown by acetylene, 220, and miscellaneous varieties, 790. In view of the general impression that cost of manufacture, in the several industries of the country has increased faster than the return to manufacturers, it is interesting to note that the total cost of gas manufacture for 1909 shows an advance of 23% compared with an advance of 33% in value of product and 34% increase in volume.

GENERAL SUMMARY OF GAS INDUSTRY, 1904-1909.

	1909.	Per cent. of increase, 1904-1909.
Number of establishments	1,296	27
Capital	$915,537,000	26
Cost of materials used	$52,428,000	41
Salaries and wages	$33,316,000	31
Miscellaneous expenses	$27,757,000	†6
Value of products	$166,814,000	33
Value added by manufacture	$114,386,000	30
Number of salaried officials and clerks	13,515	44
Average number of wage earners employed during the year	37,215	22
Primary horsepower	128,350	76
Gas, M. cu. ft.	*150,835,793	34
Straight coal	*19,985,253	57
Straight water	1,726,082	141
Carbureted water	79,418,486	45
Mixed coal and water	40,775,283	†1
Oil	8,688,860	152
Acetylene	*25,186	220
All other	216,643	790
Coke, bushels	*82,049,683	†8
Tar, gallons	*92,152,938	36

*In addition, in 1909, 27,558,000 cu. ft. of straight coal gas, 13,070,000 cu. ft. of acetylene gas, 44,347 bushels of coke, and 38,370 gals. of tar were produced by establishments engaged primarily in the manufacture of other products.
†Decrease.

Statistics of Large and Small Factories.—A preliminary statement of the results the thirteenth census shows an increase during the five years 1904-1909 of 52,311 establishments. By establishment is meant one or more factories, mills or plants, owned, controlled, or operated by a person, partnership, corporation, or other owner, located in the same town or city, and for which one set of books is kept. By this classification the various plants of a large industrial combination like the Steel Trust are considered as separate establishments. The number of establishments having an annual product of over $100,000 was 30,344 out of a total of 268,491 in 1909. Although these composed but 11.5% of the total number of establishments they employed 4,912,161 of the total of 6,615,046 wage earners, or very nearly three-quarters. Two-thirds of the total number of establishments produced less than $20,000 a year each in products. A summary of the statistics for the two years 1909 and 1904 is given as follows:

Industry and value of product.	Number of establishments.	Average number of wage earners.	Value of products.
All Industries:			
1909	268,491	6,615,046	$20,672,051,870
1904	216,180	5,468,383	14,793,902,563
Less than $5,000:			
1909	93,349	142,430	222,463,847
1904	71,147	106,353	176,128,212
$5,000 and less than $20,000:			
1909	86,989	470,075	904,724,296
1904	72,791	419,466	751,047,759
$20,000 and less than $100,000:			
1909	57,269	1,090,380	2,544,348,079
1904	48,096	1,027,047	2,129,257,883
$100,000 and less than $1,000,000:			
1909	27,823	2,896,475	7,946,817,284
1904	22,246	2,515,064	6,109,012,538
$1,000,000 and over:			
1909	3,061	2,015,686	9,053,698,364
1904	1,900	1,400,453	5,628,456,171
Per Cent. of Total Falling Within Each Class:			
Less than $5,000:			
1909	34.8	2.2	1.1
1904	32.9	1.9	1.2
$5,000 and less than $20,000:			
1909	32.4	7.1	4.4
1904	33.7	7.7	5.1
$20,000 and less than $100,000:			
1909	21.3	16.5	12.3
1904	22.2	18.8	14.4
$100,000 and less than $1,000,000:			
1909	10.4	43.8	38.4
1904	10.3	46.0	41.3
$1,000,000 and over:			
1909	1.1	30.5	43.8
1904	0.9	25.6	38.0
Average per establishment:			
1909	....	25	$76,993
1904	....	25	$68,433

Railways in China are making some progress in spite of the disturbance of the past year. We learn that the Yunnan, Szechuan & Teng Yueh Ry. has had a 33-mile line located from the French railway at Pi Chi Tchai (Mongtze) to the Ko Kin tin mines. The rise is 1,400 ft., but fairly light construction for a mountain line has been secured by the use of 2½% grades and four switchbacks. The line is to be built practically along the Tropic

of Cancer. The rainy season of May-September is said to have been the worst for 20 years, with the result that the French railway (only 1½ years old) was badly broken by landslides. Some of these came far above and buried the tracks, while others started below the line and left it without support. As that line has no pile drivers or steam shovels and all earthwork is done by men with baskets it was expected that through traffic would not be resumed before December or January. In the proposed great trunk line to be built under the $50,000,000 foreign loan the American section was to be from Ichang west along the gorges of the Yangtze River, and would be, it is said, the most difficult stretch of railway location and construction yet undertaken in China.

Personals.

Mr. Geo. W. West, formerly a consulting engineer of Los Angeles, Cal., has been appointed City Engineer of Glendora, Cal.

Mr. Geo. A. Johnson, Assoc. M. Am. Soc. C. E., has been engaged by the New York State Conservation Commission to investigate and report upon the pollution of shellfish in New York waters.

Mr. Thomas Aitken, M. Inst. C. E., of Scotland, and Mr. Ernest Storms, of Belgium, have been engaged to act as consulting engineers for the Coleman du Pont memorial road under construction across the State of Delaware.

Mr. Fred L. Johnson, who was recently City Engineer of Santa Barbara, Cal., has become Supervising Engineer for the Southern Sierras Power Co., in charge of the construction of a high-tension transmission line between San Bernardino, Cal., and Bishop, Inyo Co., Cal.

Mr. Creighton H. Hollingsworth, Member American Society of Engineering Contractors, formerly Superintendent of Construction for the Buffalo Dredging Co., Buffalo, N. Y., has become Superintendent for O'Toole & McGilleray, General Contractors, of Ottawa, Canada.

Mr. Samuel Higgins has resigned his position as General Manager of the New York, New Haven & Hartford R. R., effective Jan. 1, and that position has been abolished. The duties hitherto performed by Mr. Higgins will devolve upon Mr. H. J. Horn, who has been made Vice-President, in charge of operation.

Mr. S. D. Clinton, Assoc. M. Am. Soc. C. E., who for the past three years has been Chief Engineer of the Portneuf Marsh Valley Irrigation Co., at Downey, Idaho, has resigned that position to resume a general engineering practice with his partner, Mr. Charles H. Mull, City Engineer of Twin Falls, Idaho, under the firm name of Mull & Clinton.

Mr. Frederick D. Clapp, M. Am. Inst. M. E., and Mr. Myron L. Fuller, formerly in charge of water-supply investigations in the eastern United States for the U. S. Geological Survey, have formed what they term "The Bureau of Associated Geological Engineers," with offices in the Board of Trade Bldg., Boston, Mass., and at 331 Fourth Ave., Pittsburgh, Pa. The Bureau will undertake investigations not only of ores and mineral deposits, but of water-supply problems, as well as examinations for bridge and dam foundations and tests of materials.

Obituary.

John B. Fleming, a mill designer well known among mining men in the western United States, was killed Dec. 17 at Reno, Nev., by falling from the roof of a hotel.

Hugh J. McGowan, President of the Indianapolis Traction & Terminal Co., died Dec. 19 at his home in Indianapolis, Ind. Mr. McGowan was born on his father's farm at Liberty, near Kansas City, Mo., Jan. 24, 1857.

I. C. Johnson, a pioneer in the manufacture of Portland cement, died recently at Gravesend, England, aged nearly 101 years. Through a printer's error, the line announcing his death was omitted from the obituary notice published in this column last week.

Herman Pfister, a manufacturer of engineering instruments and supplies, died at the Bethesda Hospital, Cincinnati, Ohio, Dec. 14, aged 64 years. Mr. Pfister was born in Switzerland, where he acquired his first knowledge of civil engineering instruments. He came to this country when a young man, and became the manufacturer of surveying instruments at Cincinnati, Ohio, in 1870. His son, Mr. Wm. H. Pfister, will continue the business in Cincinnati.

Robert M. Breredon, M. Inst. of C. E., died at Woodstock, Ore., Dec. 7, age 78 years. Reports state that Mr. Breredon was employed in 1854 and 1855 in the office of I. K. Brunel, the designer and builder of the steamship "Great Eastern." From 1857 to 1870 he was in charge of the building of the Great Indian Peninsular Ry., connecting Bombay with Calcutta and Madras. Mr. Breredon was sent to America in 1871 to examine the railway systems of the United States to obtain information for the railway department in India. In 1872 to 1876 he was employed as consulting engineer of a large irrigation enterprise in California. He prepared a plan for the irrigation of the San Joaquin Valley, only a portion of which was carried out, however, owing to the death of the principal financier of the undertaking. Mr. Breredon was sent to Washington, D. C., in 1875 by a number of prominent men of California to interest Congress in irrigation projects in that state. From 1877 to 1904, the date of his retirement from active practice, he was consulting engineer for various mining and irrigation projects in the Pacific Coast States, South Africa and the Northwestern Territory of Canada. Mr. Breredon is survived by two sons and a daughter.

Engineering Societies.

COMING MEETINGS.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27-Jan. 3. Annual meeting at Washington, D. C. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
Jan. 6. Annual meeting at Seattle, Wash. Secy., Joseph Jacobs, 803 Central Bldg., Seattle, Wash.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Jan. 9. Annual meeting at New York City. Secy., J. R. Wemlinger, 13 Park Row, New York City.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Jan. 9. Annual meeting at New York City. Secy., W. R. Ingalls, 505 Pearl St., New York City.

MICHIGAN ENGINEERING SOCIETY.
Jan. 9-11. Annual meeting at Lansing, Mich. Secy., Alba L. Holmes, 574 Wealthy Ave., Grand Rapids, Mich.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 16. Annual meeting at Pittsburgh, Pa. Secy., Elmer K. Hiles, 3511 Oliver Bldg., Pittsburgh, Pa.

WOOD PRESERVERS' ASSOCIATION.
Jan. 16-18. Annual convention at Chicago, Ill. Secy., F. J. Angier, Mount Royal Station, Baltimore, Md.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at New York City. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 17-19. Annual meeting at Urbana, Ill. Secy., E. E. R. Tratman, 1138 Monadnock Block, Chicago, Ill.

SOCIETY OF AUTOMOBILE ENGINEERS.
Jan. 18-20. Annual meeting at New York City. Secy., Coker F. Clarkson, 1451 Broadway, New York City.

KANSAS ENGINEERING SOCIETY.
Jan. 23-24. Annual meeting at Manhattan, Kan. Secy., W. S. Gearhart, Manhattan, Kan.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 23-25. Annual meeting at New York City. Secy., W. W. Macon, 29 West 39th St., New York City.

OHIO ENGINEERING SOCIETY.
Jan. 24-26. Annual meeting at Cleveland, Ohio. Secy., Clyde J. Knisely, New Philadelphia, Ohio.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 24-26. Annual meeting at Montreal, Que. Secy., C. H. McLeod, 413 Dorchester St., West Montreal, Que.

INDIANA ENGINEERING SOCIETY.
Jan. 25-27. Annual meeting at Indianapolis, Ind. Secy., Charles Brossman, Union Trust Bldg., Indianapolis, Ind.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 14-15. Annual meeting at Boston, Mass. Secy., N. W. Gifford, 26 Central Square, East Boston, Mass.

IOWA ENGINEERING SOCIETY.
Feb. 21-23. Annual meeting at Davenport, Iowa. Secy., S. M. Woodward, Iowa City, Iowa.

American Society of Mechanical Engineers.

At the January meeting in New York City, President Humphreys will address the members on matters now engaging the attention of the Council. The chairmen of various standing committees will give short talks recounting their recent activities and explain some of the problems now before their respective committees.

Washington Society of Engineers.

The annual meeting was held at Washington, D. C., in the Cosmos Club at 8 p. m., Dec. 19. About 125 members were present. Officers for the ensuing year were elected as follows: President, John H. Hanna; Vice-President, Frank Sutton; Secretary, John C. Hoyt; Treasurer, H. B. Stabler; Directors, M. O. Leighton, F. W. Albert, A. L. Baldwin, W. A. McFarland, E. N. Johnston and J. A. Holmes. Following the election, Dr. Geo. W. Littlehales gave an address entitled "The Engineer As a Motor in Civilization."

American Society of Civil Engineers.

At the regular meeting held Dec. 20 at the Society's house, New York City, papers were presented as follows: "Construction of the Morena Rock Fill Dam, San Diego Co., Cal.," by M. M. O'Shaughnessy; "The Halligan Dam, a Reinforced Masonry Structure," by G. M. Houston, and "Provisions for Up-Lift and Ice Pressure in Designing Masonry Dams," by C. L. Harrison. The first two papers were printed in the October and the third in the November numbers of the "Proceedings."

Kansas State Good Roads Association.

The tenth annual meeting will be held at Emporia, Kan., Jan. 17-18. The program of papers to be presented includes the following: "Gulf to Winnipeg; or Benefit of Cross-State Highways," John C. Nicholson, Newton; "Progress in Good Roads in Kansas in 1911—Our Present Needs," W. S. Gearhart, State Highway Engineer; "The State's Relation to Good Roads," Hon. Arthur C. Tapper, Topeka; "Advantages of the New Road Law," Hon. J. M. Gray, Kirwin; "Interpretation of the New Road Law," Attorney-General Dawson; "Stone Road Construction," Senator G. H. Hodges, Olathe; "Necessity of a New Bridge Law," C. F. Osborne, County Engineer, Howard; "The Railroad and Good Roads," Frank Jarrell, Topeka; "Sand-Clay Roads," W. B. Harris, County Engineer, Hutchinson; "Oiled Roads," J. M. Allen, Chanute.

American Association for the Advancement of Science.

The meetings of Section D, to be devoted to Highway Engineering, will be held in Washington, D. C., on Dec. 29 and 30. Papers, to be presented on Dec 29, are as follows: "History of the Washington Bituminous Concrete Pavements," Capt. Martin Brooke, Engineer-Commissioner of the District of Columbia, Washington, D. C.; "History of Tar Concrete Pavements in Ontario," W. A. McLean, Provincial Engineer of Highways of Ontario, Canada.; "Surface Treatment of Park Roads," Col. Spencer Cosby, Corps of Engineers, (in charge of buildings and grounds, Washington, D. C.); "Oyster Shell Roads," Walter W. Crosby, Chief Engineer, State Roads Commission, Baltimore, Md.; "The Chemistry of Modern Highway Engineering," Prevost Hubbard, Chief of Division of Roads and Pavements, The Institute of Industrial Research, Washington, D. C.; "A Review of the Use of Bituminous Materials in the Construction and Maintenance of American Highways during 1911," Prof. Arthur H. Blanchard, Columbia University, New York City; "Organization of the Highway Maintenance Department of the Borough of the Bronx," William H. Connell, Assistant Commissioner of Public Works, Borough of the Bronx, New York City; "Organization of the Engineering Department of Coleman du Pont Road, Inc.," Frank M. Williams, Chief Engineer, Coleman du Pont Road, Delaware; "Organization of Convict Labor on the Virginia State Highways," P. St. J. Wilson, State Highway Commissioner of Virginia, Richmond, Va.; "Cost of Road Building with Convict Labor," Dr. Joseph H. Pratt, State Geologist of North Carolina, Chapel Hill, N. C.; "Utilization of a Motor Truck Train in the Maintenance of Trunk Highways," Logan Waller Page, Director, Office of Public Roads, Washington, D. C.; "Pipe Systems in Streets," C. E. Bolling, City Engineer of Richmond, Va.; "Street Asphalt Paving Mixtures," H. B. Pullar, Chief Chemist, American Asphaltum & Rubber Co., Chicago; "Some Limitations of Distributing Machines," Henry B. Drowne, Columbia University, New York City; "Impact Testing Machine for Bituminous Binders," Walter H. Fulweiler, Engineer, United Gas Improvement Co., Philadelphia, Pa.; "Changes in Pitch under Exposure and Traffic," Walter W. Crosby, Chief Engineer, State Roads Commission, Baltimore, Md.; "Value of Blown Asphalts and Their Manipulation," H. B. Pullar, Chief Chemist, American Asphaltum and Rubber Co., Chicago; "Method for the Determination of Centrifugal Free Carbon in Bituminous Compounds," Walter H. Fulweiler, Engineer, United Gas Improvement Co., Philadelphia, Pa.; "Voids in the Aggregates of Bituminous Concrete Pavements," Arthur H. Blanchard, Earl R. Donle, Clifford M. Hathaway, Columbia University, New York City.

On Saturday, Dec. 30, the members will visit the plants of the Office of Public Roads and the Institute of Industrial Research and will inspect the experimental bituminous surfaces and bituminous pavements at Chevy Chase and at Park Heights Ave., Baltimore, Md.

Supplement to

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